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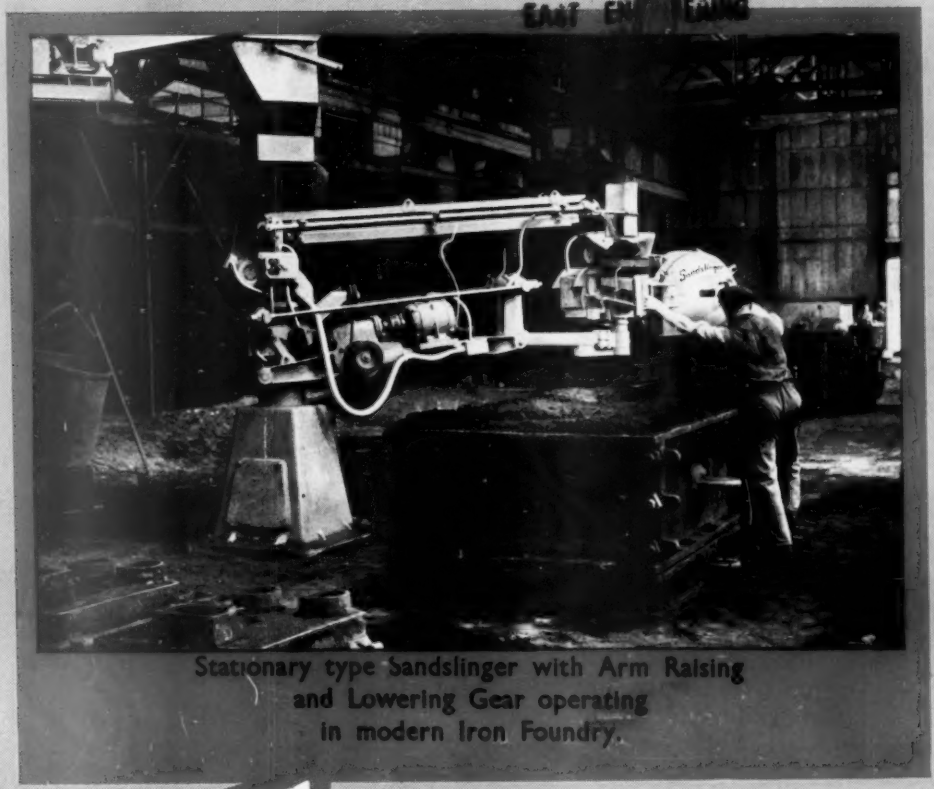

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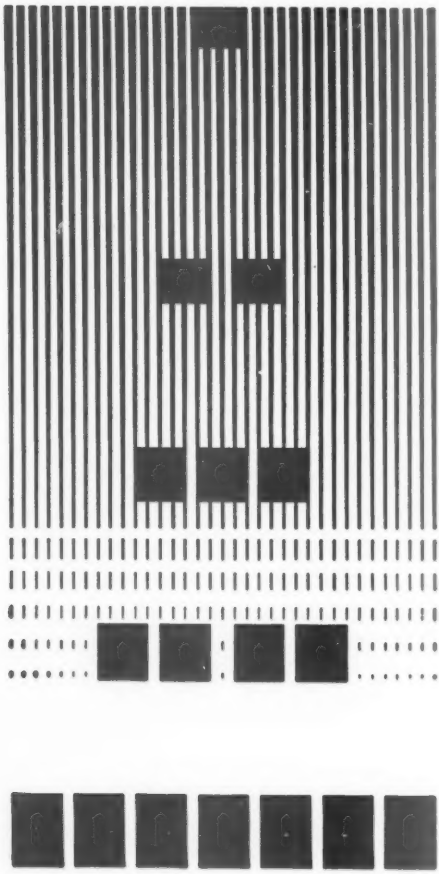

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FOUNDRY TRADE JOURNAL

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Business Portents

The business portents for the New Year are obscure. Effects of the oil shortage are difficult to assess, but should not exert a banal influence in the second half of the year, though the impact of the credit squeeze is likely to continue throughout the year. At the moment, shipbuilding, iron and steel, heavy and electrical engineering, and machine tools are all well placed, whilst the textile industry is making a better showing. On the other hand, the automobile, and those industries making goods for domestic consumption, are short of orders. Yet because building is still going ahead and agriculture is in good shape, the demand for castings used in these industries is sufficient to prevent a real slump.

To assess the prospects for the ironfoundry section of the industry is an impossible task, as each foundry follows the pattern of the trading demands of its major customers, the conditions for which we have indicated. The steel-founders start the year with a good order-book, and should continue to be reasonably well employed as they are not greatly affected either by the credit squeeze or petrol restrictions. Bronze and brass founders have had, we believe, a record year and present conditions should continue for some time, but they may experience some slackening of business later in the year. However, their net is widely spread over a multitude of industries. Light-alloy founders have been expanding over the last decade, and whilst they are at present suffering from slackness in the automobile trade, new outlets are constantly being found for their productions. The magnesium-alloy section is being particularly enterprising in its search for new fields.

Founders as a whole can look upon the vicissitudes of trade with equanimity, as they supply a multitude of alloys in the cast form to a huge variety of trades and industries. Invariably, there are some sections of the industry which are busy; even during the slump in 1929-30, founders catering for the light industries were kept reasonably well occupied. An immediate concern of the foundry industry is to find both internal and external transport using fuel other than petrol, and much resourcefulness is being, and will be, exercised in overcoming this problem. On the finished-goods side, a number of foundries have devoted much time, energy, and money to perfecting very efficient oil-burning units and whilst obviously sales of these will be difficult in the near future, in the long run, this is a useful and increasingly important outlet for castings. For the first time since the war, founders have to respond to a buyers' market and much intelligence will be needed to keep proper balance between output and results accruing from sales. The only reliable data from which this balance can be established is a proper cost system.

A. H. SULLY, M.Sc., Ph.D., F.I.M., F.Inst.P.

Director, British Steel Castings Research Association

Featuring . . . .

DR. A. H. SULLY, M.SC., F.I.M., F.INST.P.

DR. A. H. SULLY, the director of the British Steel Castings Research Association, made his first acquaintance with metallurgy when, having graduated with first-class honours in physics at the University College of North Wales, Bangor, he started, in conjunction with Professor E. A. Owen, a research on iron/nickel alloys. This work took over four years and its happy culmination was the award of M.Sc. and Ph.D. degrees.

In 1939, Dr. Sully joined the staff of the Mond Nickel Company, Limited, and by 1942 was placed in charge of the physics department, of their Birmingham laboratory. Here the development of alloys for use at elevated temperatures, resulted in the production and extensive commercial use of the Nimonic series of alloys. The book Dr. Sully wrote on Creep and Creep-resistant Alloys in 1949, achieved the distinction of being the subject of a translation (pirated) into the Russian language. In 1946, Dr. Sully took charge of the metallurgical and physics departments of the newly established Fulmer Research Institute, where he found sponsored industrial research much to his liking. After participating in research on new aluminium alloys, chromium, zirconium, and uranium, he found the work so interesting that he published two further books on chromium and manganese, together with, in association with his colleagues, some 20 scientific papers.

In 1955, Dr. Sully threw in his lot with the foundry industry on being appointed associate director of the British Steel Castings Research Association. For a year or so he travelled widely both at home and abroad, studying the technical needs of the manufacturers of steel castings. Then he took over from Dr. R. J. Sarjant, who had been director for a period after his retirement from the chair of Fuel Technology at Sheffield University. The Association, under Dr. Sully's direction, is now looking forward to a considerable expansion of its activities which result from the erection, equipping and staffing of its new research laboratory in Sheffield which was occupied in November. With these new facilities becoming available, it may be expected that the Association will make important contributions to the advance of steelfoundry technology in this country.

Dr. Sully is a member of the general Council of the Institute of British Foundrymen, and is also a member of the Ministry of Labour Joint Standing Committee on Conditions in Steel Foundries and of the Ferrous Metals Committee of the Interservices Metallurgical Research Council.

Correspondence

CRACKING OF SHELL MOULDS

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—In the course of a series of determinations of the thermal expansion of cured sand/resin mixtures, we have obtained results which are of interest in the light of a statement made by Braybrook and Waters in their paper on "Some Aspects of Shell-moulding Theory" (JOURNAL 20.12.56) namely that "If a shell is cured at a high temperature it tends to fail by cracking."

Briefly to summarize our results, it was found that shells made with Lynn SS sand containing 3 to 6 per cent. resin had expansion coefficients (linear) of between 11 and 15×10^{-6} in the temperature range 20 to 200 deg. C, after curing at 200 deg C. Within the limits of the variations inherent in the method, there appeared to be little or no difference in the results whether the mixture contained dry powder resin or whether the sand had been precoated. In neither case had the percentage of resin present any marked effect and when the base sand was changed to a coarser grade (Redhill F) similar results were again obtained. A change in curing temperature, however, gave rise to a significant difference in the values of the coefficient. For example, two mixtures were made up, one containing 6 per cent. of a dry powder resin and the other containing 6 per cent. of a (different) resin precoated on to the sand grains. One batch of test-pieces from each sample was cured at 180 deg. C, the lowest practicable curing temperature, whilst a second batch was cured at 230 to 240 deg. C. Expansion coefficients were measured with the following results:—

Curing Temp.	Coefficient of expansion (in. $\times 10^{-6}$) Dry powder resin	Precoated
180 deg. C.	10.6	8.3
230 to 240 deg. C.	15.3	11.6

These figures seem to confirm Braybrook and Waters' observation, and also suggest a reason for it. The expansion coefficient is obviously not the only factor in thermal stability; tensile strength and thermal conductivity must also be taken into account. Braybrook and Waters have shown that the tensile strength decreases as the temperature rises, falling to a constant rather low value at about 200 deg. C. It seems desirable, therefore, to produce a shell which will expand as little as possible in the temperature range where the tensile strength is low but in which the resin is still intact. At higher temperatures when the resin first fuses and then decomposes there will be sufficient pore-space to take up the expansion of the silica grains without setting up any undue stress on the shell as a whole.

The tendency in designing shell-moulding machines seems to be to cut down the curing time by applying a relatively high temperature, and whilst this is desirable from the production angle, the shells obtained may be thermally unstable and tend to crack during pouring. This is a point which merits more consideration from the manufacturers of moulding machines than it has so far received.—Yours, etc.,

F. LESERVE AND H. D. SEGROVE.
British Industrial Sand Limited.
Foundry Laboratory, Holmethorpe,
Redhill, Surrey.
December 27, 1956.

THE Telegraph Construction & Maintenance Company, Limited, has opened new branch offices and stores at 49, King Edmund Street, Dudley (Worcs).

Acknowledged, with thanks . .

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(To be continued)

"Aspects of Shell-moulding Theory."—Correction: In the master key below Fig. 14 of the part of the Paper printed on page 574 of last week's issue of the JOURNAL, sand No. 4 (Redhill H) was incorrectly represented as a black circle instead of the hollow circle to denote the values for scratch-hardness of shell moulds made with this sand in the illustration referred to. It follows that the hollow circles in graphs, Figs. 18, 19, 20 and 21, also indicate the values for Redhill H sand. Apologies are tendered to Authors and readers for this error.

Radio-isotopes and their Use in the Foundry Industry*

By Dr. S. M. Makin

Since isotopes have been readily available in this country, an ever increasing number of people have become aware of the potentialities of radio-isotopes and have become skilled in the handling of them. An impressive range of applications of isotopes have been reported in literature, all of which depend on well-established properties. The interest lies in how those may be applied to solve particular problems. Consequently, the properties of isotopes will be set out in this paper and examples given of how each has been applied to the foundry and allied industries.

The nucleus of every atom contains neutral particles, known as neutrons, and charged particles called protons. The isotopes of any element are a particular series of atomic nuclei containing the same number of protons but each having a different number of neutrons. For example, there are 9 isotopes of iron all containing 26 protons and 26 to 34 neutrons. Four of these isotopes are stable and are combined to form ordinary inactive iron. The other five isotopes are unstable and are produced by particle bombardment in a pile or high-energy machine.

Unstable isotopes emit radiation of three possible kinds known as α, β and γ radiation.

(1) α radiation—a helium nucleus consisting of two neutrons and two protons; (2) β radiation—positive or negative electrons, and (3) γ radiation—an electromagnetic radiation produced within the nucleus of generally shorter wavelength and higher energy than X-rays.

Radio-tracer Technique

The basis of the radio-tracer technique is that this emission of radiation can be used to mark the position of unstable nuclei which are detected by the ionization they produce in a counter or on a photographic plate. Douglas[1], for example, used isotopes as a marker when he mixed tantalum 182 with inactive tantalum in special steel melts to make them easily identifiable. Comparable labelling methods have been used by the Russians and are described by Yanushkovsky[2]. Voice[3] reports the use of cobalt 60 as a radioactive indicator to measure the wear of blast-furnace refractory linings. He describes how the source was inbedded in the furnace lining at a critical depth and dropped out after an allotted amount of wear. The activity was detectable through 2 ft. of furnace wall and its absence was noticeable, 10mC being detectable in 300 tons of iron.

Activity can also be used to label a few atoms in a system which is homogeneous in every other respect. Thus, a small amount of active liquid added to a bulk of similar inactive liquid metal can be used to find the rate of flow through a process by watching for an increase in counting rate as the activity passes detectors placed at different stages in the process.

Alternatively, the active metal may be chemically different from the surrounding atoms. For example, Samarin[4] describes how active phosphorus has been added to the bottom of a furnace during a period of intense boiling and samples taken at regular intervals to determine the rate at which equilibrium was attained.

Quantitative results can also be obtained with radioactive tracers since the amount of activity detected depends upon the concentration present, provided a given proportion of the activity in the specimen always reaches the detector. Travin and Shavartsman's[5] work on the passage of sulphur from pig-iron into the slag of the system $CaO - Al_2O_3$ illustrates this point. Active sulphur mixed with ordinary sulphur was added to the pig-iron and iron samples taken by sucking the molten metal through a canal into a quartz tube. A decrease in sample activity was observed as purification proceeded.

Another important feature of radio-tracer work is the very small quantities of active material which are detectable. Thus, for Fe^{55} irradiated to saturation, disintegrations take place at a rate of 2.66×10^{10} per minute per gm. with the result that 10^{-5} gm. of iron can be detected with conventional apparatus without special effort. Philbrook, Goldman and Helzel[6] were searching for quantities of this order of magnitude when they used Ca^{45} to study the distribution of calcium between molten slags and iron saturated with carbon. Twenty gm. of iron were melted with sufficient carbon to saturate it. Slags of various composition were added and the sample heated for a given length of time. After quenching in a copper block, the slag and filings from the top of the metal were counted. All the activity was found in the slag and remelting the specimens with more slag yielded no activity in the metal or slag. It was concluded that less than 6×10^{-5} per cent. of calcium was present in the liquid iron.

Ca^{45} has also been used by Kalinkov and Samarin[7] in firebrick composition in an investigation

* Paper read before the Birmingham branch of the Institute of British Foundrymen. It is thought that Dr. Makin is the first lady to present a Paper to the Birmingham branch; she is on the metallurgical staff, Atomic Energy Research Establishment, Harwell.

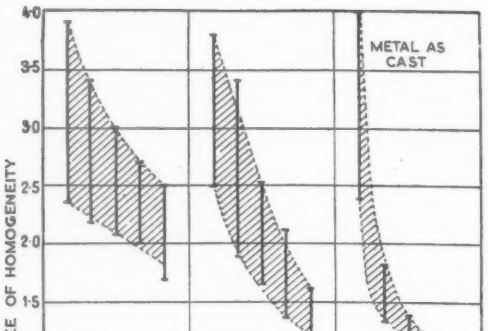


FIG. 1.—*Variation of density and therefore degree of phosphorus segregation in a steel containing* 0.42 *per cent. C. and* 0.021 *per cent. P. before and after forging with different periods of annealing treatment.*

of the contamination of steels from refractory materials. The non-metallic inclusions were isolated from the steel by electrolytic dissociation and tested for radioactivity.

Other work on the use of radio-isotopes as tracers in the Russian steel industry was reported by Samarin[4] at the Geneva conference. This work included research on:—

(1) Phosphorus and sulphur distribution in iron and slag;

(2) Diffusion of iron in acid slag and the effect of stirring;

(3) Speed of distribution of elements in a liquid steel bath;

(4) Melting speed of alloys added to a bath;

(5) Melting speed of scrap added to open-hearth furnaces by measuring the rate of dilution of an active charge.

(6) Sulphur absorption by metal charges from atmosphere of open-hearth furnaces; and

(7) Thickness and density of the skin formed on the surface of dissolving metals and number of elements absorbed by it.

Photographic Effect

Another useful property of α, β and γ radiation is its power to blacken a photographic plate. There are two ways in which this property has been used in the foundry industry. First, in autoradiography when active material is incorporated in the test-piece and a photographic plate is used to measure the distribution and intensity of the radiation. Secondly, in radiography when rays from an outside source are passed through an inactive specimen and the emergent beam recorded photographically.

The photographic method can also be used quantitatively since the degree of blackening produced on the photographic plate is proportional to the intensity and duration of exposure to radiation, this blackening can be measured in a microdensitometer. In a design by Kohn[8], a small diaphragm scans a magnified image of the film and the intensity variations in the transmitted cone of light are recorded by means of a photomultiplier.

To produce an autoradiograph, an active specimen is pressed firmly against a film and after an appropriate exposure, is developed in the usual way. The method is most suitable for use with α or β radiations since surface structures of the specimen only are recorded. Carbon 14, for example, self-screens at about 38μ so that radiation from deeper in the specimen would be absorbed before it reached the surface. Kohn and Doumerc[9] have used this technique in their study of the influence of forging on phosphorus segregation in steel. A cast deoxidized steel was made containing radio-phosphorus. The base was cut off, for comparative tests in the as-cast condition, while the remainder was forged on a drop hammer into a series of coaxial cylinders of diminishing diameter. The specimens were sectioned through the centre, then ground and polished. A heat treatment of 1,100, 1,200 and 1,300 deg. C. for 8, 16, 32, 64 hrs. was given, followed by autoradiography and etching. The films were studied under the microdensitometer and the ratio of the phosphorous content in the interdendritic space and in the axial regions in the neighbourhood of the dendrite measured. The reduction in heterogeneity due to increasing temperature and time of anneal is shown in Fig. 1.

When γ radiation is present, specimens must be ground to a few microns thick so that the autoradiograph is not confused by radiation coming from inside the specimens. Plumb[10] describes how he mounted his specimens in a 0.5μ depression in an aluminium holder. He then reduced the thickness to 30μ by filing, and down to 10μ by grinding. He used 600 grade alundum to reach a thickness of 4μ and gave the final polish with magnesium oxide. He recommends the use of a protective layer between the film and the specimens to prevent chemical attack. This 1μ layer was applied by dipping the specimen for 30 sec. in a 1 per cent. solution of Saran in methyl-ethyl-ketone followed by baking for half an hour at 150 deg. C.

Kishkin and Bokstein[11] have used a similar technique to find the distribution of the components in metal alloys under various conditions. In a 0.007 per cent. niobium/nickel alloy, for example, the niobium concentration was found to be 32 per cent. higher at the grain boundaries than within the grain. Heat treating a cast specimen for 60 hours at 1,200 deg. C. caused no change in composition but a marked levelling occurred however after 1 hour when a wrought specimen was used. Hoecker, Wilkinson and Kellison[12] have developed a hinge technique to facilitate direct comparison of autoradiographs with the etched specimen surface. This arrangement, which is shown in Fig. 2, can be

used with magnifications up to ×100. During exposure the specimen was clamped to the emulsion but was folded back for processing. Microscopic examination was made through the glass of the plate, the metal surface being seen behind the autoradiograph.

Absorption of β and γ Rays

The applications discussed so far have involved the direct observation of a radioactive source by means of a counter or photographic emulsion. If, however, the rays are passed through an absorber a nearly exponential diminution in intensity occurs as the absorber thickness is increased. Consequently if, as in radiography, β or γ rays are passed through a heterogeneous material and are recorded on a photographic film a variation in film blackening is observed, corresponding to density variations in the test-piece. This technique has been found to supersede X-rays for the radiography of heavy metal castings, and forms a popular alternative to X-rays for the radiography of smaller specimens, on account of the small size and comparatively low cost of the equipment which requires no water cooling or electrical supply.

Mullins[13] has written a good review of this subject and illustrates it with the typical arrangement of source, test-pieces and films shown in Fig. 3. Ideally a small intense source is required and if the exposure time is to be kept low, a short specimen-film distance is generally used. Too short a distance, however, should be avoided as it results in an unequal magnification. Consequently, a distance of about 6× the maximum thickness of the specimen is generally used.

The range of useful sources now available is shown in Table I. These now cover a range of thicknesses in steel from 0.01 to 6 in. Tantalum 182 has not been listed as it is now superseded by cobalt 60 which has a longer half-life and gives better definition over a wide range of thicknesses. The new fission product source caesium 137 is also listed. Although the initial cost of this source is high, its long half-life results in an infrequent need of re-irradiation. This makes it a practical source for industrial users requiring a limited amount of radiography. Morgan[14] has drawn up a useful exposure chart for steel radiography with iridium, caesium and cobalt and compares the performance of these three sources. He recommends caesium for steel thicknesses of 1½ to 3 in. and gives advice on the handling and protection required when using these sources. Similar work has been done by Halmshaw[15] on the new source thulium 170. He suggests the use of 1 to 2 thousandths of an inch lead intensifying screens in front of the film and 10 to 20 thousandths foils behind the film. Exposure charts for aluminium and steel are given.

The changes in radiation intensity due to different absorber thicknesses have been found to be sufficiently sensitive for this property to be used in the design of thickness gauges. This method of thickness gauging is particularly useful under factory conditions for the continuous monitoring of hot or moving metal sheet. In transmission gauges, the metal passes between the source and counter and a direct reading for the thickness is obtained without touching or stopping the metal. It is usual to include a second detector and standard source in the gauge and to nearly balance the absorption due to the standard source against the test-piece using a meter to indicate the residual out of balance condition. A list of useful sources and the range of thicknesses for which they are most suitable is also given in Table I.

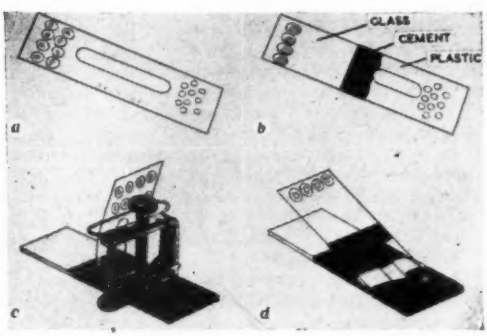
The lower limit of thickness gauging with Thallium 204 has been extended by Syke[16] by using collimators which cause the rays to pass nearly normally through the specimen and into the detector. This increases the accuracy of measurements at the lower limit of β gauging by a factor of five.

Syke[17] has also designed a thickness gauge using Thulium 170 for the measurement of hot steel strips and tubes of 0.05 to 0.30 in. thick. In this design, the thermal radiations from the hot metal energized a relay which opened a shutter in front of the source and started the counter system before the

TABLE I.—*Table of Sources for Thickness Gauges and Radiography.*

Isotope.	S^{35}	Pm^{147}	Tl^{204}	$Sr^{90}+Y^{90}$	$Ce^{144}+Pr^{144}$	Tm^{170}	Se^{75}	Ir^{192}	Cs^{137}	Co^{60}
Range of transmission gauges in steel, in. ..	0–0.00025	0·00006–0·00055	0·0005–0·007	0·003–0·032	0·005–0·05	0.01–0.3	0·25–1·0	0·25–1·5	0·25–1·5	0·5–3·0
γ Radiography range in steel	—	—	—	—	—	0.01–0.3	—	0·5–2·5	0.5–4·0	2·0–6·0

FIG. 2.—(*a*) *Flexible coverslip with sections mounted;* (*b*) *shortened flexible coverslip with specimens that require staining with solutions that can soften plastic coverslip mounted on attached glass coverslip;* (*c*) *clamp and wire retainer hold coverslip away from nuclear track plate for processing; and* (*d*) *finished autoradiograph with attached coverslip.*



arrival of the strip. Tubes were monitored by passing the source down the centre of a rotating tube while a detector outside recorded the thickness of the spiral which had been explored.

Backscattering of β and γ Rays

Another very useful property of β radiation is the backscattering effect which occurs when a solid is placed behind the source. If a source, detector and specimen are arranged as in Fig. 4 the detector is found to be sensitive to variations in specimen thickness[18]. This is a very useful way of measuring thicknesses when it is not possible to put the source and detector on opposite sides of the test-piece. In the limit, a saturation effect occurs at 2.5 half-thicknesses and is proportional to the square root of the atomic number of the backscatterer. Consequently, materials of low atomic number are used to line lead castles when minimum backscattering is required. The effect has also been applied to the β ray backscattering measurements of plated thicknesses. Thallium 204 has been used this way to measure up to 2 thousandths of an inch of tin, atomic number 50, plated upon iron, atomic number 26. The thickness of paint on steel may also be measured this way.

It is also possible to backscatter γ radiation although in early apparatus thick screening was necessary to shield the detector from penetrating radiation coming directly from the source. Developments in electronic engineering, reviewed recently by Putman[18], make use of the Compton effect which arises with backscattered γ radiation. During the elastic impact of a γ ray with an electron, the electron recoils and the radiation continues with reduced energy in another direction. Consequently, by designing equipment sensitive to radiation over a limited range of energies, it is possible to detect the backscattered γ rays only and ignore rays coming directly from the source.

There is one more important application of radio-isotopes which is the inverse of the methods described so far. In this method, the physical properties of the radioactivity are measured and the constants used to establish the indentity and quantity of the unknown isotope. This is called radioactivation analysis. The essential difference between this and the other methods is that known amounts of activity are not introduced into the experiment initially. The experiment is completed before irradiation takes place and the quantity and distribution of activity found afterwards. The work of Putman[19] on the determination of the solidification boundary in continuously-cast aluminium illustrates this distinction. Putman added a small amount of inactive gold to the stream of molten aluminium flowing into the mould. The billet was then sectioned and irradiated. Autoradigraphs taken after the aluminium activity had decayed showed a cusp of active gold delineating the solidification boundary.

Radioactivation analysis is also often used in conjunction with chemical methods as in a recent determination of trace quantities of phosphorous in pure iron[20]. The iron was irradiated and the phosphorous ultimately converted into magnesium ammonium phosphate. The specific activity and yield of this chemical were measured and hence the phosphorous content of the iron calculated.

The examples cited above are only a few of the ways in which isotopes have been used in metallurgy. They illustrate, however, the two main advantages to be gained from the use of radioactive isotopes. First, they enable a whole range of experiments to be performed which would be impossible without them, *e.g.* self diffusion and metal-transfer experiments beyond the range of microchemistry. Secondly, a number of experiments may be carried out more easily and cheaply than has hitherto been possible, *e.g.* radiography and continuous thickness measurements without touching the samples. Workers in research and industry have been quick to appreciate the advantages of radioactive techniques which will undoubtedly take their place among the established scientific methods of the laboratory and factory.

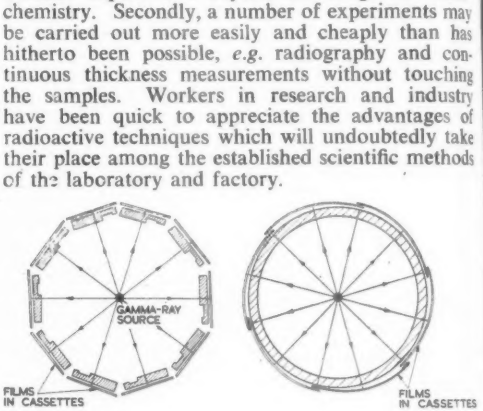


FIG. 3.—*(a) Radiographic examination of a large number of castings arranged around an unshielded gamma-ray source, and (b) arrangement for using an unshielded gamma-ray source for the simultaneous radiography of a circumferential weld in a pressure vessel.*

DISCUSSION

New Possibilities for Graphitization Research

After MR. H. G. HALL had proposed and MR. J. L. FRANCIS seconded a vote of thanks to Dr. Makin, the discussion was opened.

MR. J. L. FRANCIS said the industry had recently discovered how to produce nodular or spheroidal graphite in iron in the as-cast condition by incorporating a small percentage of magnesium into the molten iron. Could one use radioactive magnesium in order to find out whether (or how) that magnesium remained in the nodules when they had been produced?

DR. MAKIN said that unfortunately no information about suitable radioactive isotopes of magnesium had been published to date. C. E. Mellish[21], however, had found a new magnesium isotope Mg^{28} with a half-life of 21.2 hours but this had not yet been produced in metallic form.

MR. FRANCIS asked whether it would help if the transformation of graphite into the spheroidal form

were effected with cerium, because the addition of this element was an alternative means of producing nodular-graphite iron.

DR. MAKIN said such investigations could be carried out with radioactive cerium, which had a suitable half-life and energy.

Temperature Measurement

MR. HALL said the lecturer had stated that some work had been done on a liquid-steel bath and he gathered that there was an introduction of scrap to the bath and, in some way, the absorption of the added material in the bath was measured. Was there any way, by the use of radioactive isotopes, of measuring the temperature of a molten-metal bath without inserting a thermocouple?

DR. MAKIN, in reply, said disregarding contamination, one could choose a radioactive material with a melting point approximately the same as the temperature required and use this as a temperature indicator. On sampling the metal, no "count" would be obtained until the bead melted when the counts from the sample would increase. The bath would be contaminated after the isotope melted.

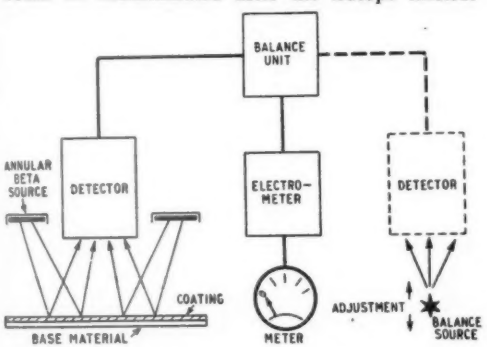


FIG. 4.—*Backscattering type of beta-particle thickness gauge.*

Application to Carbon Diffusion

MR. HALL then said that when reference was made to carbon[14], particularly with regard to the autoradiographic method, it was mentioned that one ought to have a thickness of only a small number of μ *i.e.* in order to get a radiograph to show distribution of the carbon in the material, it ought to be very thin. He was particularly interested in carbon and silicon and diffusion of these in the solid state—was the necessity of having a thin sample a real difficulty?

DR. MAKIN replied that with carbon, it did not matter how thick the material was that contained carbon.[14] Only 38μ of the material below the surface would emit β rays, activity from deeper layers being absorbed. As far as using it in determining carbon distribution was concerned, it was not a very easy material to handle, experiments had been carried out but they were very difficult.

MR. HALL continued by saying it would seem to be a practical proposition, for instance in the malleable process, one could have a small portion of white iron with a radioactive isotope of carbon[14] in it. After annealing, its autoradiograph should show how and at what rate the carbon had diffused.

DR. MAKIN insisted that the operator would need much skill in handling carbon,[14] but it could be used, with great care and trouble.

Effect of Decay

MR. T. R. TWIGGER asked whether Dr. Makin could enlarge on the rate of decay, was it specific?

DR. MAKIN, replying in the affirmative, added that the rate was unchanged by high temperatures.

MR. TWIGGER, therefore, suggested that if one were to use the technique over a long period there might be some difficulty in correlating the results with the decay of the isotope and he wondered whether the radioactive technique could be applied to a sort of metal-holding "vacuum flask" which was likely to hold metal molten for long periods of time. Could one conceive anything being added to the refractory lining which would be useful in that one could get satisfactory readings and apply a suitable correction factor to the known rate of decay of the activity itself?

DR. MAKIN pointed out that there was no need to be afraid of this calculation, it was quite simple. When an isotope had a half-life $t_{\frac{1}{2}}$, the time correction was usually made by correcting the reading N, taken t sec. after the beginning of the experiment to the value N_o appropriate to the state at the beginning of the experiment by using the formula:

$$N = N_o \text{ exp. } - 0.0693\ t/t_{\frac{1}{2}}$$

In her personal experience of gold, which had a half-life of 2.7 days, she could never complete an experiment in less than two days so she always corrected her results for the decay of gold. The correction was available to a greater degree of accuracy than the counts which had to be corrected.

MR. J. W. DEWS said he was interested in the cæsium[137], with a half-life of 33 years, and being able with that source to investigate very small sections. He had been interested, also, in using iridium[192]. The lecturer had said something about the expense of obtaining one of these could be justified.

DR. MAKIN replied that a caesium source cost something in the region of £100 for the size of source in which she thought Mr. Dews would be interested. With iridium, it would be necessary to send it back for reactivating after quite a short period.

REFERENCES

[1] D. L. Douglas. *Nucleonics*, **12** (1), 16, 1954.
[2] V. A. Yanushkovsky. Meetings of the Division of Technical Sciences Session of the Academy of Sciences, U.S.S.R., on the Peaceful Uses of Atomic Energy, July 1-5, 1955, Moscow. Publishing House of the Academy of Sciences of the U.S.S.R., 1955, p. 200.
[3] E. W. Voice. Radio-isotopic Technique II. H.M.S.O., 1952, p. 23.
[4] A. M. Samarin. *Proc.* International Conference on the Peaceful Uses of Atomic Energy, Geneva, **15**, 151, 1955.
[5] O. V. Travin and L. A. Shvartsman. Ref. 2, p. 48.
[6] W. O. Philbrook, K. M. Goldman and M. M. Helzel. *Trans.* A.I.M.E., **188**, 361, 1950.
[7] E. S. Kalinnikov and A. M. Samarin. Ref. 2, p. 3.
[8] A. Kohn. Radio-isotope Conference II. 1954, p. 68. Butterworths.
[9] A. Kohn and J. Doumerc. *Metal Treatment*, **22**, 387, 1955.
[10] R. C. Plumb. Review of Sci. Instrum., **26** (5), 489, 1955.

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Radio-isotopes in the Foundry Industry

[11] S. T. Kishkin and S. Z. Bokstein. *Proc.* International Conference on the Peaceful Uses of Atomic Energy, Geneva, **15**, 87, 1955.
[12] F. E. Hoecker, P. N. Wilkinson and J. E. Kellison. *Nucleonics*, **11**, (12), 60, 1953.
[13] L. Mullins. J. Brit. Inst. Radio Engns., **15** (3), 131, 1955.
[14] R. S. Morgan. *Brit. J. App. Phys.*, **7** (1), 25, 1956.
[15] R. Halmshaw. *Brit. J. App. Phys.*, **6** (1), 8, 1955.
[16] G. Syke. Radio-isotope Techniques. Vol. II, 1952. H.M.S.O., p. 144.
[17] G. Syke. J. Brit. Inst. Radio Engns., **14** (9), 419, 1954.
[18] J. L. Putman. *Electrical Review*, **157** (25), 1153, 1955.
[19] J. L. Putman. *J.* Inst. Metals, **82** (8), 414, 1953.
[20] *Metal Treatment*, **23** (125), 66, 1956.
[21] C. E. Mellish. Publication Pending.

New Research Laboratories at Cleckheaton

New research laboratories at the works of British Belting & Asbestos, Limited, Cleckheaton (Yorks), were formally opened by Prof. J. B. Speakman, professor of textile industries at Leeds University last month.

The company was founded in 1878 to weave "Scandinavia" belting for power transmission and moved to bigger sites as it grew, from Dundee to a factory near Perth, then to Lanark, and finally in 1901 to the present site at Cleckheaton, where about 1,500 people are employed. Since the research and testing laboratory, established in 1924, houses now about 50 workers, it can be seen that the ratio of scientific to production workers is very high. The effectiveness of this policy is shown by the fact that the first PVC coated and impregnated "Scandura" belt was installed underground in 1947. Apart from conveyor belting, the factory produces mine cable-slings, asbestos protective clothing of every sort, power transmission belting, clutch and brake linings for use on excavators, cars, and winding engines, insulating textiles, gaskets, packings and jointing. Foundry conveyor belting and knock-out conveyors are also made by the company at Cleckheaton.

The new building is designed to give the greatest possible amount of daylight to its occupants, has a floor area of 23,600 sq. ft., and cost £200,000. It is clad in the local Crosland Moor stone of a pleasant biscuit colour. The chemical laboratory benches, in addition to the usual gas, electricity, and water services, are fitted with compressed air and low-pressure steam supplies, the pipes being in ducts under the benches.

A large room in the new building is used for testing the wear and friction of brake or clutch units or linings. Several machines are installed, of which the largest, of 140 h.p., has flywheels which give it an energy capacity of over 18,000,000 ft.-lbs. Part of the new building, the "pilot lab," is equipped for processing, in new or old ways, brake linings, belting, and other rubber-asbestos products of the company.

The small first floor is occupied by offices, a cloakroom, library, textile research laboratory, microscope room, and dark room. The building can be extended when required, by a third storey and by extension of the ground floor.

Steel Output Tops Previous 1956 Peak

Expansion in Pig-iron Production Expected

Expansion of pig-iron output by at least 1,000,000 tons is expected in 1957. The extra production from furnaces blown in November and December, with the additional output expected from the North-East Coast, Lincolnshire, and Scotland this year, should boost pig-iron production to over 14,000,000 tons.

The Iron and Steel Board states that a like increase in steel production is expected this year. The total production for 1956 should be about 20,600,000 tons and there should be capacity available for a possible output of over 22,000,000 tons this year. Figures for November show another increase. The October total was the highest October figure recorded, but fell just short of the March peak. The November rate of 426,400 tons a week just tops the March rate of 425,800 and is 17,800 tons up on the rate for November, 1955.

So far the 10 per cent. cut in fuel oil has been offset by the substitution of coal-tar fuel. Efforts are being made to overcome difficulties which have arisen in other departments, particularly in works transport and ancillary activities, by the cut in gas/diesel oil.

Output Figures Compared

The following table gives the latest steel and pig-iron output figures (in tons) and compares them with earlier returns:—

Period.	Pig-iron.		Steel ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate.
1956—September ..	252,500	13,131,000	417,000	21,686,000
October ..	260,700	13,558,000	419,100	21,791,000
November ..	262,700	13,660,000	426,400	22,172,000
1st 11 months	252,500	13,131,000	397,400	20,665,000
1955—September ..	246,200	12,804,000	397,800	20,683,000
October ..	249,200	12,957,000	399,500	20,773,000
November ..	252,600	13,135,000	408,600	21,246,000
1st 11 months	238,900	12,425,000	380,500	19,785,000

Pig-iron production in November averaged 262,700 tons and the estimated total for the year is 13,200,000 tons. One new furnace came into production in Lancashire in November, and a large new furnace in Middlesbrough was being blown in last month.

Preliminary results of the limited census of consumers' stocks of steel taken at September 30 indicate that total stocks held by consumers and merchants had increased by 9.7 per cent. in the first nine months of 1956 compared with an increase of 7.1 per cent. in 1955 and an average post-war increase of 4.4 per cent. per annum. The third quarter showed a slight decline in total stocks.

Ending of Tinplate Control

Following the Home Secretary's announcement in the House of Commons on November 20 that control of tinplate, terneplate, and blackplate would terminate at the end of 1956, the Board of Trade has made an Order revoking the Iron and Steel Distribution Order, 1951, and Amendments Nos. 1, 2, 3, and 4 to that Order, thus terminating control over the acquisition, disposal, treatment, use, and consumption of tinplate, terneplate, and blackplate.

The Order (SI 1956, No. 2028) came into effect on December 31.

Development and Application of a Foundry Test for Assessing Shrinkage Behaviour in Grey Cast-iron*

Discussion of the Paper by J. Grice and J. T. Berry, B.Sc., Ph.D., A.I.M.

Comments on this Paper when it was presented in Cardiff showed fundamental differences between practical and research viewpoints and this led to a certain warmth in the interchange of opinions between the protagonists. Initially, the Authors reviewed their experimental findings and these were substantiated at a later stage by another worker in the same field. It was clear, however, that the practical founders present would not accept their explanations of shrinkage phenomena—at least not in relation to large castings. Not until the final contribution—which postulated that mere size was a variable which itself could vitiate small-scale experiments—was "oil poured on the troubled waters." It was clear that much more work is necessary before general conclusions can be drawn from this sort of research.

Authors' Introduction

Mr. Grice in introducing the Paper made the following comments:—

It would be fair to say that in this Paper an attempt had been made to reconcile the scientific approach of the problem of feeding castings with the facts as they faced the methods engineer actually on the foundry floor. The Authors had attempted, probably very inadequately, to question whether it was possible to calculate the dimensions of feeders. There were two main aspects to the problem as indicated in the Paper, *viz.*:—

(1) There was the fundamental premise upon which the Paper was based, the Chvorinov theory, which in recent years had met with criticism on both sides of the Atlantic. (2) In the light of recent American work, the effect of temperature gradient and relative cooling rates was considered. In addition, it had been felt that certain external agents, for example, atmospheric pressure, would play a significant part.

Preliminary work had been concerned with the effect of change of riser-volume: surface-area ratio and depth of unsoundness in a 6-in. cube in a medium-phosphorus grey iron. Although this series of relationships (Figs. 2 to 12) did contribute valuable information on the simple system concerned, it displayed several disadvantages, the most important of which was that the difference between "centre-line" shrinkage, sinks, and under-riser shrinkage, was not developed. A more suitable test had been formulated and several experiments carried out, whereby records of temperature gradients in the casting and feeder during solidification and corresponding shrinkage defects were made available.

It was concluded that for the particular alloy used:—(*a*) Chvorinov's rule was only partially successful, under riser-shrinkage persisting; (*b*) that the criterion of Pellini regarding temperature plateaux was not entirely applicable and that the issue was further complicated by the action of atmospheric pressure for certain relative cooling rates of riser to casting, and (*c*) that although feeding in the latter stages of solidification appeared to take place, the persistent under-riser shrinkage probably depended on the absence of "mass-feeding."

The slides were then shown by Dr. Berry who, when explaining the diagrams, said that considering Fig. 15, and taking the larger rectangle (to the right of the diagram), there were isochrones, *i.e.*, temperatures at particular times (denoted as minutes) along one arm of the 24-in. horizontally cast bar test-piece. Immediately beneath this were shown graphically the defects as revealed by X-radiography on 1-in. thick slices cut at right angles to the axis of the long cylinder, and in Fig. 15 only was shown how the density changed along the bar. Considerable thought had been given to the particular methods used and the density test was eventually discarded because it was not entirely suitable for indicating the coarser type of shrinkage, in addition to which carrying out the test was extremely time-consuming. Consequently, from Fig. 16 onwards, the Authors had preferred the radiographic representation of unsoundness.

The smaller, thinner rectangle in Fig. 15 represented the temperature gradients at various times up the riser, which was in the centre of the 24-in. bar. Thermocouples had been put into this riser and along the bar and it had been assumed that both arms of the bar had a similar thermal history. After cooling and knocking out the mould, the right-hand part of the bar had been sectioned, as seen in Fig. 13 and X-radiographs had been taken. (In further relation to Fig. 15, the two radiographs were illustrated at this stage, confirming the findings of shrinkage.)

Solidification Phenomena

Dr. Berry then explained that there was an ambiguity in his account which might suggest that the work of Ruddle and Skinner of the British Non-Ferrous Metals Research Association followed that of Gittus and Hughes, which of course it did not. Under the heading "Comments," the sentence beginning "A second important conclusion these workers made," was the statement that the BNFMRA work on the solidification of aluminium-bronze, aluminium/silicon and various other non-ferrous alloys, indicated that with such non-

* Paper printed in the FOUNDRY TRADE JOURNAL, August 16, 1956.

equilibrium centres of solidification so near the surface, solidification probably took place at a temperature other than the equilibrium value. It had to be borne in mind that particular metals probably solidified at various temperatures, dependent upon the rate of heat-extraction through the mould. From this fact, it was inferred that cooling through a certain temperature did not necessarily mean a point of 10 per cent. or even complete solidity, as was very nicely confirmed by Gittus and Hughes in the British Cast Iron Research Association's *Journal of Research and Development*. These workers had shown that nucleation and growth of the eutectic cells was occurring at parts of a casting which were quite remote from each other and that, in addition, the rates of the processes appeared to bear no direct relation to distance from this mould/metal interface.

DISCUSSION

MR. G. R. SHOTTON then read a contribution from MR. E. LONGDEN, in which he referred first to his remarks presented during the discussion of the Paper by Mr. Hughes and Mr. Gittus, and suggesting that they were also applicable to the present Paper, with the following additional remarks:—

The Authors had referred to the effects of the dry-sand mould on a lathe-bed casting. If the Authors ever had the misfortune to scrap one of those lathe beds, they would, he thought, find ample evidence of liquid shrinkage in very many parts of the casting away from the sliding surfaces which received special treatment. He felt that they had been led astray by the opinion of Mr. Gittus in his previous work that the sand walls expanded into the metal, under certain mould conditions, thus reducing the apparent liquid shrinkage. Whilst the rigidity of the mould wall was of paramount importance in resisting ferro-static pressure and shell expansion consequent on graphite growth, it could hardly be expected that the sand would expand with sufficient force to counteract the enormous pressure of graphite growth. As an example, to produce a chilled roll, suitable metal was poured into a cast-iron mould, a solidified shell was formed quickly and the chill began to expand away from the casting. At the point when the metal met the very rigid mould, two opposing influences began to operate, but in that brief contact the metal of the casting was influenced by the resistance to shell expansion, by the high thermal-conductivity of the metal mould and the subsequent resistance of the solidified shell of the casting itself, to the progressive formation of graphite.

Concluding his remarks, Mr. Longden recommended the Authors to read about the experiments which he himself had carried out. Although it was now 33 years since those experiments were made, the information and conclusions in respect to the influence of varied qualities of mould materials still stood.

MR. GRICE, in reply, said he had never seen a lathe-bed broken up and he had certainly seen no radiographs of one, so he would assume that what had been said was correct. However, he had to admit that he had read Mr. Gittus's Paper not long before writing his own part of the present Paper and, as what Mr. Gittus had to say seemed reasonably sound, he had taken it to be true. He further added that such was the quality of proof shown by Mr. Gittus in the British Cast Iron Research Association's *Journal of Research and Development*, that one was bound to accept such information.

DR. BERRY, also in reply, asked what the foundryman really wanted. Investigators had to tell the truth. Mr. Gittus had put in spherically-ended rods and connected the ends of them to displacement meters of some kind and he had actually recorded the movement for his particular conditions. What more proof could be demanded?

More Experimental Results

MR. J. H. GITTUS at this point said he would like to describe some experimental results which supported the theories which he had previously expressed:—A number of castings, 4-in. dia. and 6-in. long, had been produced in both green- and dry-sand moulds. Silica probes terminating just inside the mould cavity and attached, outside the

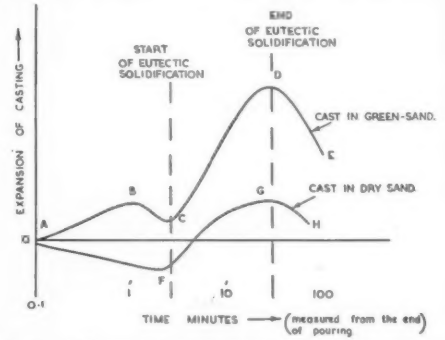


FIG. A.—*Measured expansion of castings made in green- and dry-sand moulds.*

moulding box, to dial gauges, had been employed to register changes in length of the castings, which occurred prior to and subsequent to solidification. The results generally obtained were summarized in a schematic diagram (Fig. A). During the pouring of the castings, no change in dial-gauge reading occurred. Immediately afterwards, however, the green-sand mould cavity increased in volume and since this increase occurred even in the absence of metal pressure (as had been shown by critical experiment) it must be mainly due to expansion of the heated layer of sand in immediate contact with the casting. It was quite possible that in castings which were relatively tall some expansion of the mould cavity, attributable to ferro-static pressure, could also occur during pouring—he did not question this, but merely wished to indicate that an expansion could occur in the *absence* of such pressure.

In the dry-sand mould, no such expansion was observed and in fact a contraction occurred (AF,

Fig. A). This was again attributed to the expansion of a heated layer of sand in contact with the casting; however, in this case, the expansion was supposed to take place inwards on to the contracting casting. This was quite reasonable, since the rigidity of the surrounding dry-sand would presumably make outward expansion more difficult than was the case in a green-sand mould. The transient inward movement of the sand represented by BC for the green-sand mould was similarly attributed to an increase in the rigidity of the surrounding sand, associated with the drying out of this sand by heat from the cooling casting. Such a layer of dry sand might be expected to act, to a small degree, in the same way as a dry-sand mould. Sections CD and FG in the illustration were expansions which corresponded with the period during which eutectic solidification was occurring. Evidently the expansion caused by this process could be reduced by the dry-sand mould as compared with the green; since it was inconceivable that the dry-sand mould had actually prevented the eutectic from expanding (*i.e.*, from solidifying) one could only assume that the expansion had taken place in a different direction, that is to say, inwards—into previously-formed shrinkage cavities—instead of outwards. This argument was in keeping with the practical finding that the total volume of shrinkage defects in the dry-sand-moulded casting was only one-fifth as great as the volume in the green-sand-moulded casting. It appeared that, in the former case, the volume of the shrinkage defect had been reduced both by the expansion inwards of heated sand (AF) and also by the resistance afforded to the solidification and expansion of the casting itself (FG). It was impossible to give more than a cursory picture of the experiments which had led to these conclusions. However, full results had been widely published and were available for inspection.

CO_2-Process Moulds

MR. GRIEVES asked what happened with CO_2-Process moulds.

MR. GITTUS replied that they were even better than those of dry sand. The 6- by 4-in. cylinders cast in the kind of iron which he expected a foundryman would choose if he had to make them in the ordinary way of business, had a surface shrinkage effect in a green-sand mould of between 30 and 45 ml.; in a nodular iron the shrinkage effect was larger; in a dry-sand mould the shrinkage went down to about 6 ml. and in some CO_2-Process moulds, he had produced castings which did not exhibit a shrinkage effect of any measurable size.

Conflicting Evidence

MR. H. HAYNES said when he saw the pictures showing such porosity, despite all the science available at the present time, he wondered whether founders were advancing in the right direction. He had brought with him a picture of a cast-iron crankshaft, 14-in. dia., which had been sawn up. He disagreed entirely with Mr. Gittus, because he had cast 10-ton flywheels in green-sand and dry-sand and those in the latter had been out of balance 14 lb. while those in green-sand had been out but 2 lb. The "proof of the pudding was in the eating": his crankshaft was absolutely solid right through. Did present-day science assist foundrymen to make castings without blowholes or shrinkage? He very much doubted it. He also disagreed with Mr. Longden; he personally had cast lathe beds of 25 tons weight and there had been no complaints about them yet.

Chill Moulds

MR. CHERRY invited the Authors of the paper and Mr. Gittus to consider graphite expansion in solidifying iron when using a chill mould, because in that case the mould was exactly defined and thus one of the parameters about which one might argue was removed. Enormous internal pressures were set up within a casting, which could bring about very great de-coring problems if one cast a core in a chill casting, and he had seen holes inside such castings which in fact bore no resemblance to the shape desired. That was evidence of the enormous pressures, because the same core in a sand mould left a hole of precise definition. If solidifying pressure was capable of doing that with cores it would, in his opinion, be capable of having an effect on internal porosity. That was a line of attack which might well be followed in order to substantiate or disprove the theories which had been put forward.

DR. BERRY, in reply, said that in chill moulds things were further complicated by the great metallurgical differences brought about by differing cooling rates, but he believed Mr. Gittus had tried to obtain some sort of refractory mould which was very rigid, and yet had experienced the same sort of thermal characteristics, as a sand mould.

MR. GITTUS said as one reduced the rigidity of a mould so one increased the amount of porosity in a casting.

Conflict of Opinion

MR. SIDDALL said there seemed to be quite a conflict of opinion between the practical man and those on the technical side, particularly on the subject of shrinkage, and he had gained the impression from Mr. Grice that in a way he resented the criticism from the practical man. However, it would appear that the weight of evidence was on the side of the practical man in that respect: that it was not just one man or one series of tests but the weight of evidence over a number of years and produced by a number of people, and there must be some reason for the view held by the practical man. In his view it was the duty of the technical man to show why the practical man was wrong before he assumed that he himself was right.

DR. BERRY, in reply, said the snag was often a matter of reproducibility. Cast iron was such a complex material that if one, for instance, altered the phosphorus content, fantastically different characteristics were obtained. If all the technical men could co-ordinate their work, it would probably be received with much more acclamation than had been the case hitherto.

Shrinkage Behaviour in Grey Cast-iron

A Simple Solution?

MR. ROGERS said if founders were faced with the position of having many variables, not only of composition but also of casting temperatures for separate jobs, why did they not approach it in the only logical way—as he had done for years past—namely, by doing something to force the metal to become solid, by progressive directional solidification—in other words, applying chills. In the example which had been shown, surely the simple thing was to apply 1¼-in. dia. pieces of cast-iron rod in order to stimulate the freezing? What was all the fuss about?

DR. BERRY, in reply, said Pellini had already provided considerable data on just how beneficial chills were in increasing temperature gradients throughout a casting and there was obviously no need to regurgitate this. In addition, it would be seen that many people were opposed to the use of chills. He would be delighted however if someone would try a few experiments using the present test with chills.

Obviously the next step was to employ other mould materials. Here, he believed the French approach was even to go so far as obtaining directional solidification, not necessarily by using metallic chills but by the use of various sands; for example by promoting solidification by means of say a hard-rammed zircon sand (which had a high mean heat-diffusivity) and, alternatively, retarding solidification with say a soft-rammed fine silica sand which had a low mean heat-diffusivity.

Effect of Head Pressure

MR. HUGHES said he wished to elaborate slightly a comment which he had made earlier at another session, namely that much research was carried out on comparatively *small* castings. With regard to the contribution which had been submitted by Mr. Longden, on lathe beds, there was immediately apparent a most important difference, which might have some bearing on the matter. The lathe-bed casting almost certainly had a very high hydrostatic pressure in it because it was a *tall* casting, whereas the castings which Dr. Berry had been describing were comparatively squat castings. It had been proved that one could burst a beer barrel full of water by having a capillary tube high enough above it, merely because of the great height of the water, and in the same way with a high enough running system one could presumably cause a mould to dilate very considerably.

Experiments of the sort described in the Paper definitely proved something. They were carried out under carefully controlled conditions, and they proved a certain point. Because the experiments were not always on castings which were the exact shape and dimensions as ordinary foundry castings it would be wrong to say that the results were incorrect: they were in fact correct results, but when one came to make a casting in practice one added various other complicated influences. Workers who investigated castings in a laboratory unfortunately had not the facilities for investigating lathe-bed castings. It would be extremely interesting if a research could be carried out on crankshafts 14-ft. long and 14-in. dia., and if he had a research establishment which had the facilities for doing that he would be most happy to investigate the matter thoroughly. It was most important, however, that it should be realized that the design and size of a casting was a variable, and when extraneous variables were introduced, the results obtained in a laboratory test were very often no longer applicable.

Opposition to Re-siting a Foundry

A Brierley Hill foundry owner, Mr. George Albert Rutter, of Rutter Bros., who was forced, early last year, to leave his premises in Brettell Lane after 34 years in business there, appealed to the Ministry of Housing last month to reverse the decision of the urban district Council not to allow him to move to a Delph Road site.

The Council said that although the land zoned was industrial, it was not suitable for a foundry; it was bounded on one side by good-class residential property, which would be seriously affected by dust smoke and grime. They thought the foundry would be discharging smoke at about the same level as the windows of the nearby houses, and that the site in question, being next to modern houses should be occupied only by reasonably clean industry. The Council had obtained planning permission for an alternative site in Moor Street which was still available, to Mr. Rutter and he could acquire both the land and the mining rights also.

Mr. Rutter said that the foundry he planned to build would have dust extractors and spark arresters, and gas-ignited, smokeless fuel would be used, so that there would be no nuisance to local residents. At the moment, he was using premises at Wordsley, but these were too small for his needs. Negotiations over the site at Moor Street had fallen through owing to the question of price. The Ministry's decision will be made known later.

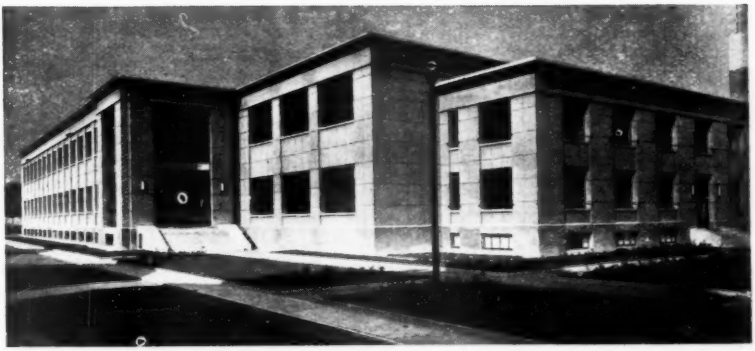
Iron-ore Imports

Iron-ore imports in November, and the totals for the first 11 months of last year compared with the corresponding period of 1955, are shown below.

From.	Month ended Nov. 30.	Eleven months ended November 30.	
	1956.	1955.	1956.
	Tons.	Tons.	Tons.
Sierra Leone	61,950	642,162	629,501
Canada	263,438	1,319,721	2,381,144
Other Commonwealth countries and Eire	—	15,071	14,372
Sweden	336,400	3,723,279	4,015,238
Norway	12,229	107,622	101,443
Western Germany	—	35,831	3,200
France	43,154	591,357	548,670
Portugal	11,669	87,481	107,636
Spain	61,203	740,368	772,672
Algeria	72,125	1,998,987	1,324,915
Tunisia	43,430	770,468	722,937
French Morocco	37,064	242,297	357,295
French West Africa	45,541	445,105	558,584
Spanish Morocco	7,525	190,593	242,156
Liberia	23,690	278,523	315,736
Brazil	47,488	482,357	507,753
Other foreign countries	102,326	196,590	685,911
TOTAL	1,160,232	11,867,812	13,289,163

French Foundry College

New Premises at Bagneux, near Paris



The original Paris foundry technical college was founded in 1923 by the *Syndicat Général des Fondeurs de France* (the French foundry employers' federation) in order to create a reservoir of well-trained technologists for the industry. Its success can be measured from the fact that its 30-odd years of existence has provided France with 664 properly-trained technologists, plus 76 for other nations. For 21 years the College was housed in *Ecole Nationale d'Ingénieurs Arts et Métiers de Paris,* but in 1948 the space at this school was needed for other purposes and temporary premises were found first at the Faculty of Sciences and then in quarters loaned from the Ministry of Technical Education. Recently, a new college has been specially built for the sole purpose of training foundry technologists and its general aspect is shown at the head of this page.

Layout

The layout of the College includes (on the ground floor) boardroom and library, staff office, lecture theatre, cloakrooms, accommodation for mechanical testing, melting and heat-treatment, an office for the head of the Physics Department, laboratories for physical testing, metallography, etching room, a dark-room and porter's lodge. On the first floor are housed secretary's, technologists' and drawing offices; directors' office; students' drawing office; reception room, sand laboratory; chemistry lecturer's office; an electrolysis section; balance room; chemical laboratory, stores and apparatus-washing rooms, cloakrooms and porter's lodge. The College is located at numbers 278 to 284, Avenue Aristide Briand, Bagneux, Paris, which is well suited to the students as it is served by a branch of the "Metro." The school is surrounded by gardens and is divided into three sections namely, administration and general services, lecture theatre and the laboratories, each floor being served by a long corridor with wide bays to give abundant lighting. Twice as much space is given over to the chemical laboratory as to the melting shop; from this can be gathered that the students are expected to have gained their practical experience in the works.

Laboratories

Great attention has been paid to the design of the chemical laboratory, as is shown in Fig. 1 The drainpipes are made of plastic and the benches are covered with ceramic tiles. Air is evacuated by exhaust ducts fitted to the table backs and these backs also separate one bench from another. Each bench has its own well-ventilated fume cupboard. Other laboratories are devoted to small-scale melting and heat-treatment (Fig. 2), metallography (Fig. 4), and raw-material testing (Fig. 5). It is fairly obvious from the illustrations that the training given—except for perhaps chemistry and physics—is designed to supplement that obtained in the actual foundries. This is a system which has a large following in this country. At the College also there is a well-equipped drawing-office, with flat-topped tables, which can accommodate 30 to 40 students. Pendant and not strip lighting is used throughout the buildings.

Lecture Theatre

The lecture theatre (Fig. 3) is well arranged for the showing of either lantern slides or films. Following a suggestion from Professor Portevin, the projection is arranged from the rear of the screen, so as to avoid interference from the lecturer's shadow. Incorporated in the lecturer's desk is an arrangement whereby, without moving, he can reproduce a series of pictures on the screen.

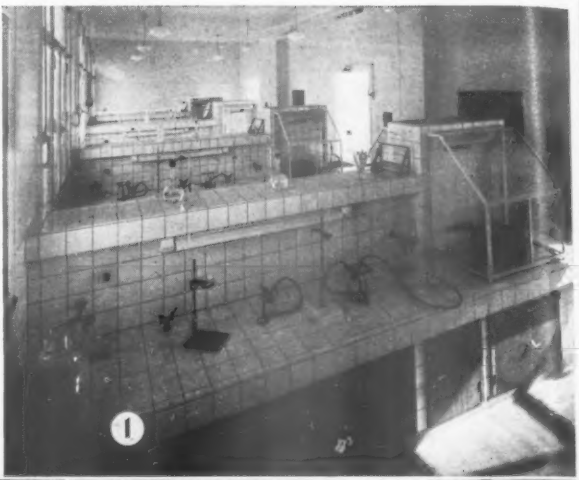
Students

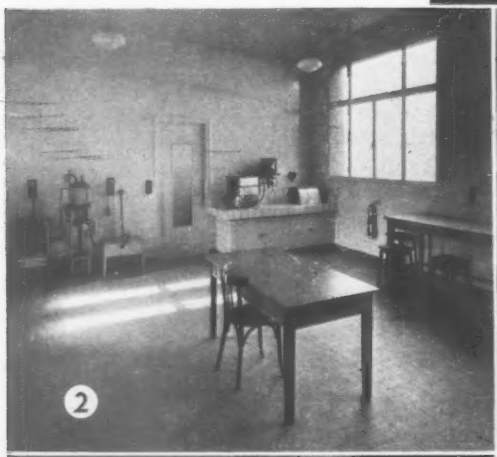
To aid in their maintenance during their period in the College, the French entrants (admitted after a competitive examination) can obtain scholarships and substantial loans which the borrower is honour bound to repay after leaving the College. Scholarships are awarded by the Higher Technical Training Authority to graduates of recognized engineering colleges, and by the *Centre Technique* to promising foundry apprentices and boys from the technical schools. It is interesting to note that 80 per cent. of the old students have positions in foundries not attached to engineering works. A further 15 per cent. were sponsored by such organizations as the railways, dockyards, automobile manufacturers and the like, and these students returned after graduation to their previous employers.

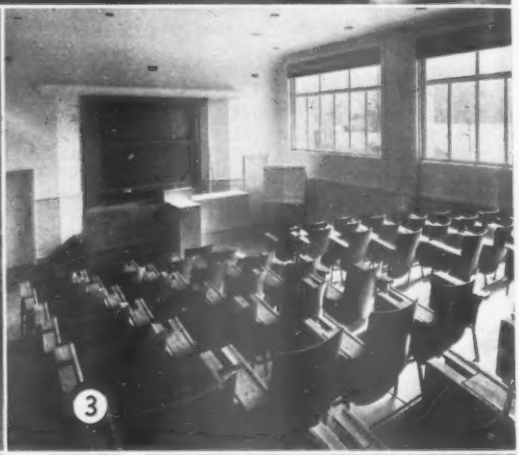
The employment of the graduates is taken care of by the Old Students' Association, in consultation

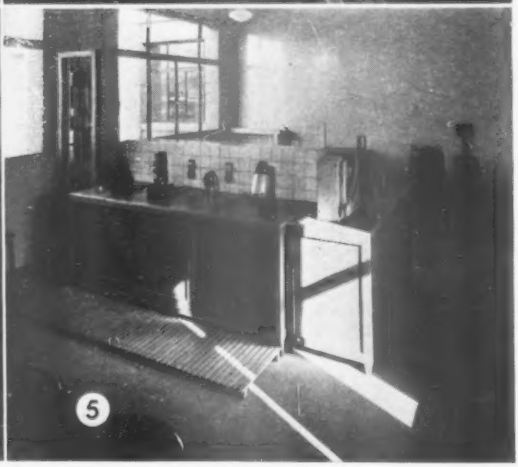
FIG. 1.—*Chemical laboratory;* FIG. 2.—*Laboratory devoted to small-scale melting and heat-treatment;* FIG. 3.—*Lecture theatre. The projection is arranged from the rear of the screen to avoid interference from the lecturer's shadow;* FIG. 4.—*Metallography laboratory, and* FIG. 5.—*Raw-material testing laboratory.*

with the director of the school. On entry, the students are between 20 and 30 years old. They should have spent from a year to eighteen months in a loose-pattern foundry, where a systematic practical course, including patternmaking and moulding, must have been undertaken. Candidates are examined during the second half of September each year, and









the successful ones start their studies in October and continue until mid-July. At Easter-time, along with their lecturers, a series of works visits is made to the foundries in the Paris area, much in the same way as is arranged in the UK at the National Foundry College at Wolverhampton.

The French College has 36 lecturers, drawn from both the University and industry, and is managed through a Council presided over by the chairman of the Foundry Employers' Federation and composed of equal representation from industry and the educational authorities. There are no residential students, those from the provinces being housed in the *Cité Universitaire*. Thus no canteen facilities have been established in the College—an omission which accords with the general conception of the French way of life. The College is under the direction of Mr. Lainé to whom thanks are accorded for co-operation in the preparation of this article.

Turbo-blower Split-delivery Control Equipment

Equipment enabling a new turbo-blower of 125,000 cub. ft. per min. capacity to serve any two or three blast furnaces, maintaining fixed air flow to each furnace and at the same time holding the blower discharge pressure at the lowest level required at each furnace, has recently been installed at the Duquesne (Pa) Works of the United States Steel Corporation. It formed the subject of a paper by James S. Frazer, Jr., at the annual convention of Iron and Steel Engineers held at Cleveland recently.

Air flow to each furnace is measured by an orifice plate and corrected to standard conditions by automatic compensation for temperature and pressure. Air flows to the furnaces are regulated by 42-in. butterfly control valves positioned by pneumatic cylinders receiving flow-controller signals. These compare air-demand signals with actual air flows transmitted by air-flow recorders. Any unbalance between these causes the output signal from the flow controller to restore balance by re-positioning the butterfly control valve. The control automatically selects the furnace requiring the highest blast pressure and holds the butterfly control valve for that furnace wide open. Air flow to this furnace is then controlled by varying blower speed while air flow to the other furnaces is controlled by throttling their butterfly control valves. This method of split-wind control results in minimum blower discharge pressure. Operating performance of the system has proved reliable, accurate and economical, states the author.

Canadian Steel Output up 17%

Canadian steel output in the first 11 months of this year totalled 4,739,187 tons, which was an increase of 17 per cent. on the corresponding 1955 output. The Bureau of Statistics reports that steel ingot production in November was 426,787 tons. This was nearly 5 per cent. up on last year's corresponding 406,772 tons.

BSA Group Report

Reference to the remarkable rate of technological progress in steelmaking was made by Mr. J. Y. Sangster, chairman, at the annual meeting of the Birmingham Small Arms Company, Limited. New inventions, new processes, new techniques were evolving rapidly, and were being closely watched to assess their importance in forward planning, he said. Substantial capital expenditure had been involved in maintaining the pre-eminent position the company held in that section of the steel industry in which it specialized.

William Jessop's Successes

The demand for special heat-resisting steels for the aircraft industry, an important part of the output of William Jessop & Sons, Limited, showed no abatement and research was maintained at a high level to improve the qualities of existing jet engine steels. An increasing number of licences in foreign countries for the production of Jessop jet engine steels on a royalty basis had been granted.

Titanium was now of major significance in the aircraft world and the new plant at Jessop's was producing 1-ton ingots—a size substantially larger than could be produced anywhere else in the UK or western Europe.

The fabrication of coal-preparation plant and materials handling equipment had been excluded from the sale of the Birtley Company, Limited, and a new subsidiary, Birtley Engineering, Limited, had been set up to acquire and develop these interests.

The steel division of the group had achieved an all-time record of sales, amounting to almost 25 per cent. more than the previous year and the intake of orders both for the home and export markets was also a record. There was no sign of a fall in the high level of export demand.

The most important development for B.S.A. Tools, Limited, had been the development and production of automatic transfer machines, which was likely to become an increasingly important section of the machine-tools business. Burton Griffiths & Company, Limited, machine and small tool factors and importers, had had a record turnover in plant and the turnover and profits of B. G. Machinery, Limited, had been well maintained.

Reorganization

Speaking of the special investigation into the structure and organization of the BSA group, the chairman said the parent company would become a holding company with a series of wholly-owned operating subsidiaries. That way there would be more scope for individuality and enterprise and the main function of the parent board would be the control of policy and finance. Sir Bernard Docker, chairman and managing director until earlier this year, and Lady Docker were present and protested against some of the financial details given.

Mr. Sangster announced that the net profit from all sources, after taxation, was £771,485 (£1,535,735) for the year ended July 31 last. Final dividend on ordinary stock would be 5 per cent., making a total of 8 per cent. (10 per cent.). Sir Bernard, asking why it had been found necessary to reduce the dividend, suggested that it might be that the board "doubted their ability to conduct their affairs . . . so as to make a satisfactory profit." The chairman replied that it would not have been prudent to have kept the dividend at 10 per cent. as the company had a bank overdraft of £2,630,000 last July.

New Equipment

Pilot Valves

Pilot valves for air, hydraulic, and vacuum working are now being produced by the Pneumatics Division of the Baldwin Instrument Company, Limited. The valves are unit-constructed and spool-operated; standard bore size is ¼ in. and three-way and four-way valves are available. Six standard operating mechanisms are available—push button, cam, single pilot, double pilot, plunger, and switch.

The prime purpose of the pilot valves is to operate larger remote control valves which in turn operate power cylinders. This means that the control valves can be located close to the power cylinder, ensuring rapid response. Pilot valves can, however, be used to control small power cylinders or even larger ones if the speed of movement required is relatively low. An application of pilot valves which is becoming increasingly important is to process control systems. In this case, pilot valves are used to operate from some remote position larger control valves which are in some way controlling the flow of fluids.

Pilot valves play an important part in the sequential control of machine movements. Any number of pilot operated combinations may be arranged in cascade, so that each power cylinder actuates the control pilot of the next cylinder in sequence. If the last cylinder in the sequence is arranged to re-initiate the first cylinder, a continuous cycling of the entire system can be achieved. Thus, a machine which is powered entirely by air or oil cylinders can be made to run automatically without the need for any external timing device. The main advantage of such an arrangement is that the machine always runs at its optimum speed, regardless of adjustments to cylinder speeds.

Slurry Pump

Almost any type of difficult water, including, for example, water containing abrasive solids, such as sand, pyrites, and coal ash, can be dealt with efficiently by the modern centrifugal pump. The slurry pump manufactured by the Pulsometer Engineering Company, Limited, Reading, embodies several new features, one of which is a pump spindle mounted on generously-rated double-ball and roller bearings representing a further improvement on the original designs.

Another feature is that the inevitable wear of impeller and sideplates can be adjusted without dismantling the pump, an arrangement which greatly reduces the time taken to effect repairs. The pump has no renewable liner, but the casing or volute, which is simple in form, is readily replaced when worn out, as it is fitted with spigots registered for automatic alignment.

These pumps are supplied in 2 to 14 in. standard sizes and cover a range of duty from 50 to 5,000 galls. per min. for heads up to about 60 ft.

For particularly severe conditions where there is danger of corrosion in addition to abrasion, stainless steel is used for the construction, especially when salt water is present, while for acid water, austenitic iron or non-ferrous alloys are employed.

Contactor Starter

A new range of push-button contactor starters has recently been introduced by the General Electric Company, Limited, Magnet House, Kingsway, W.C.2. Those now available are suitable for use on three-phase supplies at ratings of up to 7½ h.p. at 600 v., and the range is to be extended shortly to cover ratings up to 30 h.p. The starters incorporate a new design of four-pole vertical-lift contactor unit, which complies fully with BS.775:1956, and the use of a new insulating material—moulded alkyd—noted for its non-tracking and arc-resisting properties for the arc-box. The overload protection is provided by a triple-pole magnetic trip unit which is adjustable for current rating and for "hand" or "self" resetting. For installation, generous space for wiring is allowed, and "knock-out" conduit entries are provided on both sides, top, bottom and back, the terminals with captive cable clamps being conveniently clamped together. Provision is made for other forms of control such as remote push-buttons or a pilot switch, and a switch can be mounted on the side of the starter for controlling auxilliary equipment.

Pattern Milling Machine

As briefly mentioned in the reports of the Düsseldorf exhibition, the firm of Max. Strifler KG, of Kirchheim, have recently introduced a small pattern milling machine known as the "2500" model. It comes in the intermediate price range; has manual feeds and can be used in a wide range of applications in both wood and metal patternmaking. The overarm and column are horizontally and vertically adjustable. A compound table, to which can be fitted a rotary table of 400 mm. dia., is mounted on the base. To fix the blades and cutters collets are used; these are perfectly balanced and are claimed to give a vibration-free performance. A universal motor for d.c. and a.c. single phase electricity supply, 50 cycles per sec., and a three-phase current motor, 220 to 380 v., can be furnished with the unit. A very comprehensive range of standard attachments is available for use with the machine.

Photo-electric Temperature Controllers

Elcontrol, Limited, of 10, Wyndham Place, London, W.1, have recently introduced two new instruments for photo-electric temperature control, and flame failure and ignition control. The first—type PR5—is intended for temperature control in the range of approximately 750 deg. C. upwards, and would be of interest to those concerned with the heat-treatment of metals where the colour temperature of the heated object can be detected by the photocell. The second unit, type FSD2, has been designed for use with light-oil burners, and is claimed to be the only burner-controller of its type which does not make use of thermal-delay switches. The "failure-to-ignite" time is of the order of 5 secs., which is ample for flame establishment with light oils, and which in turn enables the purge-time to be correspondingly reduced.

Ferguson 35 Tractor

Many improvements over the well-known existing Ferguson model are embodied in a new tractor produced by Massey-Harris-Ferguson, Limited. The 37 b.h.p. of the Ferguson 35 gives improved output on many jobs such as shovel work or light earth-moving, and particularly for haulage of trailers. Slightly heavier than its predecessor, it has greater stability when heavy equipment is mounted, and the six forward and two reverse gears provide greater flexibility. The fact that the reverse gear position is opposite the first forward position greatly increases the speed of operation in loader work.

Automatic Processing Machine

Through their house organ, *Elema News*, Sierex, Limited, 241, Tottenham Court Road, London, W.1, announce that they have developed an automatic processing machine for X-ray films. It permits of the viewing of the films five minutes after they have been placed in the machine, and the capacity is of the order of 140 films per hour.

The Krater of Vix—A Bronze Masterpiece of 500 B.C.*

FIG. 1. — *The Krater of Vix, a vase weighing 462 lb., made of tin bronze. It was unearthed at Vix, in France in 1953.*

By Jean R. Maréchal

As a result of numerous excavations carried out in the region of Vix, not far from Chatillon-sur-Seine in Burgundy, France, there was discovered in 1953 a burial dating from the Hallstatt period (approximately 500 B.C.) which was notable because it contained an immense vase or krater made of tin-bronze, weighing 462 lb., standing 64 in. high, with a capacity of 240 gallons. This magnificent piece may have come either from Greece or Etruria, the Grecian origin being the more likely.

On the territory of the commune of Vix, Chatillon-sur-Seine (Côte d'Or) is Mont Lassois, a huge mound of chalk, rising more than 300 ft. above the valley of the Seine. The main plateau, 400-yd. long and a 100-yd. wide, has been inhabited since Neolithic times and at the end of the Hallstatt period was covered by a fortified city (second half of the VIth century B.C.: Hallstatt IIb). It was only later after a period of disuse that a retrenchment was constructed in beams of wood and iron bolts (*murus galliens*) and at the Gallo-Roman epoch it was again abandoned except for one or two villas and some small habitations which persisted until the IVth century (presence of pottery with Christian motives). A Merovingian cemetery then occupied the lower half of the plateau.

The site has long attracted the attention of archæologists and numerous examples of pottery, tiles, bones of animals, etc., had been brought to light but, in 1953, Mr. R. Joffroy, curator of the museum at Chatillon-sur-Seine, was rewarded by the discovery of an important princely burial under a tumulus between the foot of the mountain and the Seine. He had formed the opinion that the cemetery of the old habitation was not in the

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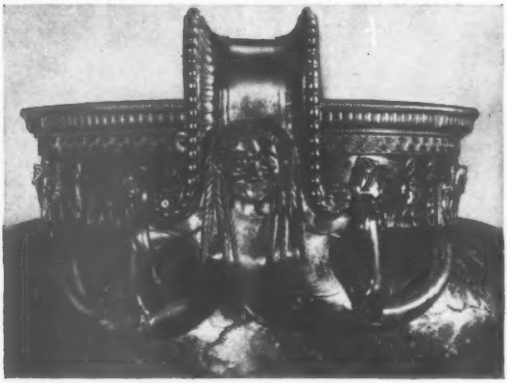


FIG. 2.—*The handles of the vase are each embellished with a gorgon and two small lions.*

mound but in a nearby field where, in fact, digging at a depth of less than six feet, he came upon a bronze handle, and on excavating further unearthed the enormous vase (Fig. 1) to which it was attached. In this grave was the skeleton of a woman about 30 years of age wearing a heavy gold diadem (weighing over a pound) on the skull, gold and amber necklaces and bracelets, and gold brooches set with coral, amber and uncut stones.

Salient Features

The krater consists of a foot made in a single piece of hammered bronze weighing 48 lb., and the bowl is also of hammered bronze, terminating above in a cast-bronze frieze depicting a procession of helmeted and breastplated hoplites and charioteers with chariots and horses. Two handles in cast bronze fixed to the shoulder and rim of the vase are each embellished with a gorgon and two small lions (Fig. 2). The vase is topped with a cover of 41 in. diameter in hammered bronze, which has lost most of its decoration except for a small female statuette 7½-in. high, which is welded to the centre of the conically domed cover.

The bowl itself consists of a sheet of tin-bronze totalling more than 3 sq. yd. in area and without joins. Its thickness, except at the neck, is about $\frac{1}{20}$ in. This sheet must have been obtained by hammering (with intermediate re-heatings) an ingot of bronze weighing about 130 lb. until it had a thickness of about $\frac{1}{8}$ in., then it would be further beaten with wooden mallets to reduce the thickness still further and to produce the bulged shape. The extraordinary skill required for this work could be equalled by few craftsmen to-day, even starting from rolled-sheet bronze.

The micrographical examination of the bowl discloses a hammered structure. The imposition of the metal shows that the bronze contains 8 per cent. of tin and is remarkably pure, containing only the following small percentage amounts of impurities:

Lead	0.01	Arsenic	<0.01
Zinc	0.01	Antimony	<0.01
Iron	0.1	Bismuth	<0.005
Nickel	0.05	Manganese	<0.01
Silica	0.05	Aluminium	<0.01

Phosphorus Absent

The tin content of the cast bronzes used for the ornamental fittings of the vase ranges from 7 to 11.3 per cent.; the lead contents are higher ranging from 0.05 to 0.40 per cent. for the heavy pieces, but there is never any trace of phosphorus. The quality of the metal is remarkable and there appears to be no blow-holes. The execution of the handles, each weighing over 100 lb., certainly presented difficulties but the result was excellent and, in fact, one of them was quite perfect.

The micrographical examination of the handles

FIG. 3.—*Photomicrograph of bronze from the bowl (etched with ammonium persulphate:* × 200).

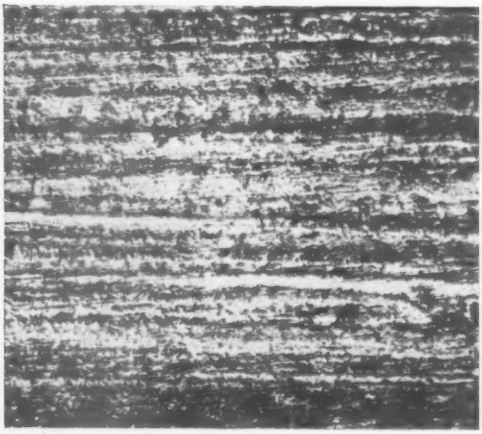
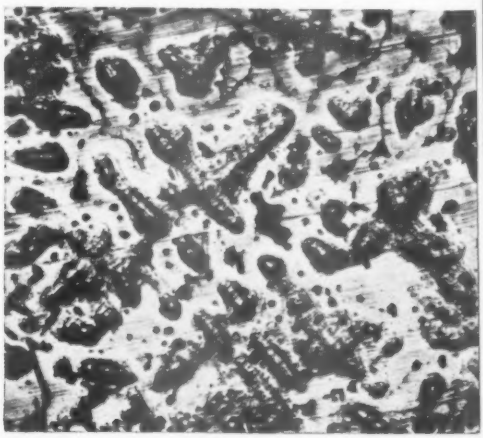


FIG. 4.—*Structure of the cast bronze of the frieze (etched with ammonium persulphate:* × 200).



and frieze shows the dendritic structure typical of castings (Figs. 3 and 4). The krater was certainly intended for sacred burial purposes. It was probably filled with wine which the Celts considered was the drink of immortality, the survival of the dead being influenced by the quantity in reserve in the tomb, which belief would explain the enormous capacity of the krater.

The discovery is impressive testimony to the cleverness and skill of the smelters, the coppersmiths and metal casters of that remote period. The author would like to acknowledge his indebtedness to the publications on this subject by Mr. René Joffroy, who originally announced these discoveries to the *Académie des Inscriptions et Belles-Lettres.*

BIBLIOGRAPHY

René Joffroy: "La Tombe de Vix (Cote d'Or)," Presses Universitaires de France, Paris, 1954.
Jean R. Maréchal: "Techniques et Civilisations," 1955, No. 19.
Jean R. Maréchal: "Cuivre, Laiton, Alliages," 1954, Nos. 20 and 21.

Promising Outlook for Apprentices

Remarks on the possible future for ironfounding as it affected apprentices at both craft and technician levels were made at the annual prize-giving of John Harper & Company, Limited, Willenhall, by Dr. J. G. Pearce, O.B.E., director of the British Cast Iron Research Association. He congratulated the apprentices on being associated with a company which had such an excellent scheme of training and urged them to acquire all the technical knowledge they could relating to the industry. He said that the industry had been transformed out of all recognition in the last 25 years on the one hand by the application of science, and on the other by the adoption of the principles of engineering production. One result of this was that the industry would need many more technicians and he thought that many craftsmen might well equip themselves to become technicians. There was a lot to be said for acquiring experience and knowledge in parallel by part-time study, he said, adding that it was not at all easy to say whether a university graduate who got his qualification by full-time study was better than a man who had acquired a similar qualification the other way. There was a tendency in the United Kingdom for industry to over-value experience and to under-value training, but a qualification should not be taken too seriously. In industry a man was judged by what he could do and if the qualification enabled him to do better, that was what it was for. The difficulties of the motor-car industry, emphasised by the problems arising at Suez, would affect the output statistics for iron castings, but he thought the difficulties were temporary. The output for the last two or three years had been at record levels and the more-informed forecasts suggested that it would rise in the future, say to 1960.

The works director, Mr. J. E. Spear, reported excellent work by apprentices, though there was a slight decline in their numbers. Guests were welcomed by the managing director, Mr. W. H. Harper, and prizes were distributed by Mrs. Harper.

Prizewinners:—Best technical-college report, George Evans (electrician); junior, Anthony Griffiths (patternmaker); best foreman's report, Graham Smith (moulder); junior, Francis Pressdee (moulder); best all-round report, Brian Higgins (metallurgy); junior, John Brant (metallurgy); moulder's cup, Raymond Bennett; runner-up, Graham Smith; best all-round finished goods, Roy Anderson (draughtsman).

Book Reviews

Oil Fuel Applications by A. T. Henly. Published by Crosby Lockwood & Son, Limited, 26, Old Brompton Road, London, S.W.7; price 35s. net.

Oil-firing is of great importance, yet no book on the subject has been published in this country for many years, and this new book by Mr. Henly does much to meet the demand which undoubtedly exists. He has made a good compromise between the requirements of the specialist for detail and those of the more general reader for basic principles. The book should be very useful to students studying heating and ventilation and fuels, and should be a good reference book for those installing and using oil-fired furnaces.

The title could be misleading, since it is really a book dealing with the application of oil fuel rather than its applications. This might seem a fine distinction but in fact, the subject matter could be quite different. The book deals mainly with standards for oil fuels and installations (12 pages); oil-storage problems (41 pages); heating of oil for combustion and flow (40 pages); oil-burning systems and burners (28 pages) and ancillary equipment, controls and instruments (42 pages). These sections are detailed but written in a concise manner. Numerous formulae and graphs are provided to help the engineer to select suitable sizes and types for pipes, tanks, flues, etc., and the comments are kept on a strictly practical basis, with only elementary mathematics and no unnecessary theory.

The later sections are directed mainly to the heating and ventilating engineer concerned with small boilers. There is a chapter on packaged oil-firing units for boilers and space-heaters (14 pages), a chapter on diesel power and heating plants (9 pages), which excludes consideration of diesel engines themselves, and one page on composite firing systems. The miscellaneous applications of oil-firing to kilns, furnaces, ovens, etc., are covered in a general manner in 19 pages. The book is completed by a section on maintenance and "trouble-shooting," a useful appendix of data, a good bibliography, and an index. A small number of minor erors and omissions were discovered but the author's intention could nearly always be determined by careful reading.

D.W.B.

Kempe's Engineers' Yearbook, 1957 (62nd edition). Published from 28, Essex Street, Strand, London, W.C.2; price (for the two volumes in a stout case), 85s. post free.

Each issue of this old-established yearbook brings something new, yet it is invariably difficult to find what has been eliminated to make room for the new matter, for all the basic information is constantly retained. Amongst the new matter in this issue there are notes on shell moulding and the CO_2 Process. It is a pity that when turning up these new headings in the index, the page numbers given are incorrect, but, fortunately, the references are only a few pages out. To glance over the range of subjects is a veritable lesson as to what the average works manager encounters in the course of his profession. Sometime in his career he has to worry about foundations, Patents and trade marks, depreciation and legal problems. These and dozens of other cognate subjects are all dealt with and, moreover, very intelligently covered. The yearbook's main usefulness is that it supplies ready access to basic information on hundreds of matters about which one is a little hazy or has forgotten entirely.

U.C.F.

New Patents

(Copies of complete specifications are obtainable from the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 3s.)

761,110. International Business Machines Corp., 590, Madison Avenue, New York, 22, N.Y., USA.

A copper-base alloy comprising nickel 5 to 15, silicon 0.1 to 2.0, aluminium 0.1 to 6.0, and/or magnesium 0.1 to 2.0 per cent., the balance being copper.

761,142. J. Hobkirk Sons & Company, Limited, Ampthill Road, Bedford.

A shell-moulding machine, consisting of an oven, a container for a mouldable mixture, and a rotatable frame, on which at least two mould patternplates are mounted. They are so fixed that on rotation of the frame they can successively or alternately be moved from a position adjacent to the container to a position within the oven. Each of the patternplates are pivotally mounted on the frame so as to permit its movement to and from an inverted position over the container. Means are provided for securing one of the mould patternplates to the container, when in the inverted position, so that the container can be swung with the mould patternplate about the pivotal mountings of the plate, to deposit the mouldable mixture on the plate.

761,170. Magnesium Elecktron, Limited, Lumm's Lane, Clifton Junction, near Manchester, Lancs.

Improvements in magnesium-base alloys (see Patent No. 757,326, FOUNDRY TRADE JOURNAL, November 8, 1956, and also No. 761,173 (not abstracted)).

The present alloy consists (apart from the usual impurities) of zinc 5.0 to 7.0, rare-earth metals 0.1 to 1.0, manganese 0.3 to 0.7, aluminium less than 0.1, iron 0.01 to 0.1, tellurium 0.01 to 0.1 per cent., magnesium consisting of the balance.

761,237. F. J. O. Hurum, 50 Dronningensgate, Trondheim, Norway.

A method of adding magnesium to molten metal having a temperature above that of the boiling point of magnesium. A powder consisting of magnesium as an intermetallic compound, an alloy, or in the metallic state, is formed into a briquette provided with a hole in which is fastened a pole or rod. By means of this pole or rod, the briquette is forcibly submerged into the metal. The briquette has a content of magnesium that will evaporate progressively over a desired length of time, which may be governed either by the content of magnesium in the compound or alloy forming the powder, or by mixing this powder with a carrier or base-substance, also in the form of a powder and of such a nature that it will not be reduced by the action of magnesium.

761,317. Société Civile d'Etudes pour Material de Fonderie, 150 Rue des Blains, Bagneux (Seine), France.

A machine for casting articles having a central cavity provided with bosses or projection which necessitates the use of a multi-part core. The core patented comprises two side pieces placed one on each side of the centre key and each side piece is, on the one hand, mounted so as to be slidable with respect to the frame of the machine and, on the other hand, pivotally connected to this frame. The axis about which the piece pivots, is partially parallel to the direction in which the piece is adapted to move in a slidable manner with respect to the machine frame.

761,324. Société D'Inventions Aeronautiques et Mecaniques (S.I.A.M.), 1, Route des Alpes, Fribourg, Switzerland.

Magnesium-base alloys containing from 2 to 6 per cent. of rare earths, wherein the rare earths present in the final alloy are in the following proportions: Lanthanum 25 to 35, neodymium 40 to 65, praseodymium 8 to 12, samarium 0.5, and cerium 2 to 10 per cent., the rest being magnesium.

761,401. Irving Rossi, 40 Wall Street, New York, 5, N.Y., USA.

An arrangement for continuously casting metal in which the metal, while cooling, passes through a mould having mould elements displaceable in longitudinal and transverse directions. Means are provided for controlling the mould elements in a continuous series of alternating cycles. Each cycle consists of a transverse closing movement of the mould simultaneously with the start of a displacement downward, followed by a transverse separating movement of the mould elements simultaneously with the start of an upward displacement.

761,422. Rheinische Rohrenwerke, A.G., Mulheim/Ruhr, Germany.

A cast polygonal ingot which after it has been cast has a circular cross-section at its base end. The transition from the polygonal form into the circular form is a gradual one, the circular-base end presenting the greatest cross-section of the ingot.

761,455. Siegfried Junghans, Grabenstrasse, 2, Schorndorf, Wurttemberg, Germany.

A casting process in which the melt during its solidification is subjected to the action of rotating magnetic fields for the purpose of influencing the crystallization procedure. The duration of the action of the fields is substantially 5 per cent. or less of the solidification time and is not directly at the end of this time.

761,550. Foundry Services, Limited, Long Acre, Nechells, Birmingham, 7.

A process for applying a volatizable chemical substance to a molten metal without allowing the chemical substance, in unvolatized form, to contact the metal. The chemical substance is placed in a chamber communicating by way of an extended duct with the outside of the chamber. The chamber is sealed. The end of the duct remote from the chamber is then immersed in the molten metal. The chemical substance is then volatized by the heat from the metal, at a variable rate which is dependent upon the distance of the chamber and the surface of the metal. It is controlled by varying the point of application of the products of volatization during the process of guiding these products into contact with the molten metal. These volatizable products can be, for example, chlorinated pitch (for cleaning cast iron), or stannous chloride (for copper-base alloys).

761,558. Rolls Royce, Limited, Nightingale Road, Derby.

A method of making a mould element for use in the casting of metals by the shell-moulding process. A moulding material Z (consisting of a mixture of at least one powdered refractory filler damped with hydrolyzed ethyl silicate) is brought into contact with a heated patternplate or die. The article so formed is hardened by application of heat while still on the pattern, and at the same time pressure is applied. The mould element is afterwards removed from the pattern.

Company News

AVELING-BARFORD, LIMITED—The ordinary dividend is being cut by reducing the final payment from 10 per cent. to 7½ per cent. and is 12½ per cent. (15 per cent.). Group gross profits fell to £687,934 (£733,850) and net profits are £287,318 (£389,754).

THOS. FIRTH & JOHN BROWN, LIMITED—The final dividend is being maintained at 6 per cent. for the year to September 30, 1956, making, with the increased interim, a total of 10 per cent., against 9 per cent. on the £5,500,000 one-class capital. Group profits, after increased depreciation provisions and a full year's debenture interest this time, rose by over £392,000.

HUMBER GRAVING DOCK & ENGINEERING COMPANY, LIMITED—Richardsons, Westgarth & Company, Limited, has been in negotiation with the company with a view to an offer for the company's capital on a share exchange basis which entails 60 fully paid 5s. shares in Richardsons, Westgarth, for each £10 fully paid share in the company. Mr. W. B. Wilkinson, secretary of Humber Graving Dock, said he had not the slightest doubt that the offer would be accepted.

STEEL COMPANY OF WALES, LIMITED—Three main reasons are given for a drop of £4,000,000 in trading profits—loss of output caused by an overtime embargo by maintenance workers, increased costs, and the heavy outlay needed to bring large new units to an economic level of output. The trading profit for the year ended September 30 is £14,228,057 (£18,313,299) and taxed profit £4,000,397 (£6,052,662). The final dividend is repeated at 2¾ per cent., again making 4 per cent. on the £16,936,041 capital, all held by the Iron and Steel Holding and Realization Agency.

CHARLES CHURCHILL & COMPANY, LIMITED, manufacturers of machine tools, etc., of London, S.E.11—Sales for the first six months of 1956 were well maintained not only for the parent company but for the group as a whole, states the chairman, Mr. J. B. S. Gabriel. The group profit shows little change from that for the corresponding period of 1955. While there has been an improvement in the orders for machine tools since the end of September, it is likely that the volume of new orders may fall short of the high level achieved in 1955. If transport becomes a serious problem, delay in deliveries may be reflected in sales. An interim dividend of 7½ per cent. for the year ending March 31, 1957, compares with a 4 per cent. interim for the previous year, but the increase is to bring the payment into better relation to the half-year's profits. A 14 per cent. final for 1955-56 made an 18 per cent. total for that year.

BRITISH INSULATED CALLENDER'S CABLES, LIMITED—With the declaration of a 4 per cent. interim dividend on the £15,000,000 ordinary capital (same on £12,350,000) on account of 1956, the company issues an interim report covering the first six months' trading. This shows turnover for the first half of 1956 totalled £68,000,000 against £59,000,000 representing half the figure for the full year 1955. Profits, however, of £3,983,000 compare with £4,813,000 (again half the full 1955 figure) and the net profit of £1,800,000 with £2,130,000. A final dividend of 8½ per cent. was paid for 1955 on the present ordinary in issue. The group trading position in the second half of 1956 is on average being maintained at a satisfactory level, but due to present disturbed conditions and the increasing difficulty of passing over higher costs, it is anticipated that while satisfactory results will be achieved for the full year they will not reach the record level of 1955, states Mr. W. H. McFadzean, chairman.

Changes of Name

Among the companies which have recently changed their names are those listed below. The new titles are given in parentheses.

CORVET, LIMITED, 68, Queen Street, Sheffield (Champion Metal Furniture, Limited).

MARMETALS, LIMITED, Central Hall Buildings, South Road, Southall, Middx (Alloy Surfaces, Limited).

RUTHVILLE ENGINEERING, LIMITED, 9, Church Road, Richmond, Surrey (R. T. Youngman, Limited).

MARLIN TOOL COMPANY, LIMITED, Bank Chambers, Bank Street, Worcester (Marlin Holdings, Limited).

COOPERS FILTERS, LIMITED, 14, Liverpool Road, Slough, Bucks (Engineering Components (Overseas), Limited).

SELECTA PORTABLE ELECTRIC TOOLS, LIMITED, 116, Victoria Road, London, N.W.10 (Selecta Power Tools, Limited).

B.B.M. (YORK), LIMITED, mechanical and general engineers, etc., of 10a, Stonegate, York (Centrajet, Limited).

METAFILTRATION COMPANY, LIMITED, Belgrave Works, Belgrave Road, Hounslow, Middx (M.T.F. (London), Limited).

STANHOPE ENGINEERING COMPANY, LIMITED, Broadmead House, Panton Street, London, S.W.1 (Stanhope-Seta, Limited).

BEKABURN, LIMITED, dealers in metals, etc., of 155, Strand, London, W.C.2 (Blackwall Industrial Supplies, Limited).

L. & R. (REFRIGERATION), LIMITED, 6, Terminus Road, Littlehampton, Sussex (L. & R. (Engineering) Company, Limited).

E. H. SMITH (COVENTRY), LIMITED, 3, High Street, Swadlincote, near Burton-on-Trent (Sherbourne Engineering, Limited).

CHARHAM ENGINEERING COMPANY, LIMITED, 3-8, Palace Chambers, Sydney Road, Enfield, Middx (Auto-Moly, Limited).

CIDREC (ECAL), LIMITED, Holyrood Mill, Holyrood Street, Chard, Somerset (Chard Agricultural Machinery Services, Limited).

OUGREE STEEL TRADING COMPANY, LIMITED, Stone House, Bishopsgate, London, E.C.2 (United Continental Steels, Limited).

AVENUE SPRING COMPANY, LIMITED, 1, Kingsland High Street, London, E.8 (Avenue Spring Company (Door Springs), Limited).

STELLAR FILTRATION & EQUIPMENT COMPANY, LIMITED, Imperial Buildings, Kingsway, London, W.C.2 (Metafiltration Company, Limited).

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference ESB can be obtained from the Board of Trade Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (telephone: CHAncery 4411, ext. 738 or 771), unless otherwise stated.

ABERYSTWYTH, January 7—Provision and laying of cast-iron and steel pipes, for the Town Council. The Borough Surveyor and Water Engineer, Park Avenue, Aberystwyth. (Deposit, £2 2s.)

AUSTRALIA, January 8—Overhead travelling crane, for the Metropolitan Water Sewerage and Drainage Board, Sydney. (ESB/30790/56.)

BIRKENHEAD, January 7—Iron castings for the 12 months ending March 31, 1958, for the Roads Committee. The Borough Engineer and Surveyor, 3, Conway Street, Birkenhead.

CAMBORNE, January 26—Screws, bolts, and nuts; galvanized tubes and fittings; copper tubing and fittings for the year ending March 31, 1958, for the Camborne-Redruth Urban District Council. Mr. S. C. Wilson, clerk to the council, Council Offices, Camborne (Cornwall).

CAMBERLEY, February 12—Cast-iron goods for the year ending March 31, 1958, for the Frimley and Camberley Urban District Council. The Engineer and Surveyor, Municipal Buildings, London Road, Camberley (Surrey).

LONDON, E.C., January 7—Castings, tools, and general plant, for the Finsbury Borough Council. The Borough Engineer, Town Hall Annexe, Rosebery Avenue, London, E.C.1.

LONDON, E., January 7—Manhole covers, gully grates, and kerb overflows, for the Wanstead and Woodford Borough Council. The Borough Engineer and Surveyor, Municipal Offices, Woodford, London, E.18.

PAKISTAN, January 23—Diesel electric locomotives, for the Railway Division, Ministry of Communications, Government of Pakistan. (ESB/30975/56.)

PAKISTAN, February 1—Electric hoist, for the Karachi Port Trust. (ESB/30976/56.)

SALVADOR, January 11—Cast-iron piping and fittings, for El Departmento de Proveeduria, Instituto de Vivienda Urbana, San Salvador, El Salvador C.A. (ESB/30508/56.)

SOUTH AFRICA, January 10—Water pumps, for the Union Tender and Supplies Board. (ESB/30753/56.)

Personal

Mr. S. LITTLE, an ex student of the Foundry College, scored a try for England in the recent Rugby League International against Australia.

Mr. A. TIPPER, M.SC. (ENG.), F.I.M., general manager of the foundry supplies division of the Harborough Construction Company, Limited, has been appointed a director of the company.

Mr. A. WOODS, the European representative of the Shalco Corporation, the American shell-moulding machine builders, was amongst the lecturers at a recent general meeting of the Swedish foundrymen's association.

Mr. C. A. WINSTANLEY has been appointed service manager of H. Leverton & Company, Limited, agricultural engineers, etc., of Spalding. Mr. Winstanley joined the company in 1951 as assistant to the general service manager.

Mr. A. M. STOKES is to relinquish his position as managing director of Stokes Castings, Limited, Union Foundry, Mansfield; in his place, Mr. H. S. JEFFERY and Mr. R. M. STOKES have been appointed joint managing directors.

Mr. and Mrs. SAM HOLMES, of Bingley, celebrated their golden wedding anniversary on December 22. Mr. Holmes, who is 74, has been employed at Dean, Smith & Grace, Limited, lathe manufacturers, Keighley, for 54 years, and is still working.

Leeds University has appointed Mr. I. CODD as lecturer in the Department of Metallurgy from October 1, 1957, and Mr. E. W. WORRALL as lecturer in ceramics in the Department of Gas Engineering and General Fuel Science with Ceramics from January 1.

The following appointments in the Vickers group are notified:—Mr. E. E. KENNAIRD, sales manager, joined the board of Cooke, Troughton & Simms, Limited, on January 1; and Mr. H. F. JUDD, general sales manager of Ioco, Limited, joined the board of that company at the same date.

Mr. W. J. W. REID, Mr. A. D. THOMSON and Mr. G. S. CRAWFORD have been appointed directors of Waygood-Otis, Limited. Mr. H. C. BRADBROOK has retired from the board and Mr. D. H. J. O'CONNOR has resigned from the board. Most of the shares are owned by the Otis Elevator Company, of the US.

THE COUNCIL of the Institute of Metals has awarded the W. H. A. Robertson Medal for 1956 and premium of fifty guineas to Mr. E. GRIFFIN, A.M.I.Mech.E., A.M.I.Prod.E. (chief engineer, Metal Sections Limited, Oldbury, Birmingham) for a paper on "Cold Roll-Forming and Manipulation of Light-Gauge Sections."

Sir ANDREW MCCANCE, chairman and managing director of Colvilles, Limited, succeeded Sir ERNEST LEVER, chairman, Richard Thomas & Baldwins, Limited, as president of the British Iron and Steel Federation, on January 1. Mr. Gerald Steel, general managing director, United Steel Companies, Limited, is president elect of the Federation for 1957.

Mr. J. GRAY BUCHANAN retired as chairman of William Jacks & Company, Limited, as from December 31, owing to advancing years. He will, however, remain a director of the company. Mr. W. GRAY BUCHANAN, managing director, has been appointed chairman as from January 1, and Mr. W. P. NAIRN becomes joint managing director as from the same date.

The Minister of Fuel and Power has appointed Mr. ROBERT WHITE JOHNSON as a part-time member of the Merseyside and North Wales Electricity Board. Mr. Johnson is managing director of Cammell Laird & Company, Limited, and Cammell Laird (Shipbuilders & Engineers), Limited, and a director of the English Steel Corporation, Limited, and Metropolitan-Cammell Carriage & Wagon Company, Limited.

The Hon. J. KENNETH WEIR will act as chairman of Wm. Simons & Company, Limited, Renfrew shipbuilders, following the acquisition of that company by G. & J. Weir, Limited, Glasgow engineers. Mr. J. RUSSELL LANG and Mr. J. W. DRYSDALE have been co-opted to the board. Mr. A. B. DAVIDSON, chairman, and Mr. R. A. CLEMENT have resigned from the board. Mr. A. J. M. MILLER, managing director, and the other executive directors will continue in office.

Mr. JOHN BULMAN, managing director for the past three years of Hawthorn Leslie (Engineers), Limited, and a director of the parent company, R. & W. Hawthorn, Leslie & Company, Limited, and of the associated company, Hawthorn Leslie (Shipbuilders), Limited, is to retire after a lifetime with the company. He was general manager of Hawthorn Leslie (Engineers) before being appointed managing director. His successor is Mr. D. G. OGILVIE, who has been general manager since 1953.

Mr. C. HAND, who has been appointed to the board of Sheepbridge Equipment, Limited, joined the Sheepbridge group in June, 1948, as assistant foundry manager at Sheepbridge Alloy Castings, Limited, of Sutton-in-Ashfield, subsequently becoming foundry manager and later production manager. In December, 1954, he was appointed general manager, foundry division, of Sheepbridge Equipment, Limited, a position he still retains. Mr. Hand is a Mappin medallist in metallurgy at Sheffield University.

Thos. W. Ward, Limited, Albion Works, Sheffield, have appointed six men who have spent all their working lives with the firm, to be local directors from January 1. They are:—Mr. ERNEST SPRINGTHORPE, chief draughtsman, constructional steelworks department; Mr. C. NORMAN BRADSHAW, personnel and administration; Mr. GEORGE PAGE, manager of the export department; Mr. R. HADFIELD, manager of foundry supplies and refractories; Mr. ALFRED KISSACK, machine-tool section; and Mr. ERIC WOLSTENHOLME, assistant to the firm's London director.

Obituary

Mr. FREDERIC CURT SMITH, late chairman and managing director of the Visco Engineering Company, Limited, Croydon, died on December 18.

Mr. FRANK BOWLING, the last surviving son of the founder of John Bowling & Company, Limited, Cyclops Foundry, Kirkstall Road, Leeds, 3, died last month. He had given nearly 60 years' service to the firm.

Only six weeks after his having been elected 1957 president of the Institution of Civil Engineers, the death took place on December 18 of Mr. HAROLD JOHN FREDERICK GOURLEY at the age of 70. He was senior partner in the firm of Binnie, Deacon & Gourley and an acknowledged expert on water engineering. He was one of the panel of four which inspected and reported on the Kariba and Kafue hydro-electric projects. He made a remarkable recovery after being seriously injured in the Weedon (Northants) railway disaster in 1951, when he lost his right arm and left leg.

News in Brief

THE 30th annual congress of the *Association Technique de Fonderie* will be held in Paris on June 3, 4 and 5.

AN "OPEN DAY" was part of the celebrations to mark the 25th anniversary of Rotherham's College of Technology.

JOHN HARPER & COMPANY, LIMITED, Albion Works, Willenhall (Staffs), again paid a Christmas bonus to all their employees.

THIS YEAR the firm of Ruston & Hornsby, Limited, of Lincoln, celebrate the hundredth anniversary of their establishment.

MCKECHNIE BROTHERS, LIMITED, of Birmingham, have appointed John Hood & Company, 55, Cheapside Street, Glasgow, C.3, as their sole selling agents in Scotland.

A SECTIONAL MEETING of the World Power Conference will be held in Belgrade, Yugoslavia, from June 5 to June 11, after which there will be a series of study tours.

J. & H. MCLAREN, LIMITED, diesel-engine manufacturers, of Hunslet, Leeds, have secured contracts worth 250,000 dollars (£89,285) for generating equipment for use in Manitoba and Alberta, Canada.

ON FRIDAY, December 21, Sir Peter Roberts, Sheffield's Master Cutler, awarded benefits, totalling £543, to 500 old people under charities administered by the Cutlers Company.

MONETARY AWARDS totalling £1,880 were presented by Ald. A. G. B. Owen, chairman and joint managing director of Rubery Owen & Company, Limited, on December 20, to 282 apprentices of the firm.

AIR CONTROL INSTALLATIONS, LIMITED, Ruislip, Middlesex, announce that their Birmingham office removed on December 17 to larger premises at Wolverley House, Digbeth, Birmingham, 5 (telephone: Midland 5148).

A FIRE destroyed part of the main office block and completely gutted the printing section of the works of John Lang & Sons, Limited, engineers, Johnstone, Renfrewshire. Arrangements have been made to carry on business as usual.

TO IMPROVE THE EFFICIENCY of their supply of industrial and medical gases, British Oxygen Gases, Limited, have carried out a number of major structural alterations to their premises at Tunnel Avenue, Greenwich, at a cost approaching £50,000.

AN ORDER for 1,100 diesel engines, worth £500,000, has been received by Leyland Motors, Limited, from Oy Suomen Autoteollisuus A.B., of Finland. The order is the latest in a series from Finland, which now covers a total of over 4,000 Leyland engines.

MAVOR & COULSON, LIMITED, engineers, are extending their premises at East Kilbride for the manufacture of the latest types of mining machinery. Mavor & Coulson were one of the first engineering firms in Scotland to start smoke-free factories.

AT a ceremony at St. John's Works, Bradford, on December 21, Mr. Elijah Hepworth, chairman and managing director of Hepworth & Grandage, Limited, engineers, presented gold wristlet watches to 26 members of the company who had completed 25 years' continuous service.

MORGAN CRUCIBLE COMPANY, LIMITED, Battersea Church Road, London, S.W.11, in a letter to their customers, ask them, in view of petrol restrictions, to order requirements four weeks ahead, and if they habitually collect their goods from Battersea, to give a week's notice of the time.

WILLIAM COTTON, LIMITED, hosiery machinists, have built a new assembly shop at Bottle Acre, Loughborough, which apart from stores and necessary buildings, will have a floor space of 30,000 sq. ft. The firm have perfected a machine which can complete 16 pairs of nylons in thirty minutes.

COLVIN-SMITH, LIMITED, manufacturers of non-corrosive cast-iron heating coils, etc., is negotiating, in competition with Russian and German concerns, for the contract to instal the piping for an atomic power plant soon to be constructed on the Continent. The company opened a new factory at Gateshead recently.

MIDLAND HEATING & VENTILATION COMPANY, LIMITED, Birmingham 11, makers of dust- and fume-control plant and cooling towers, announce that Mr. K. S. Smith has been appointed as their northern representative. He will operate from 44, George Lane, Bredbury, Stockport. (Telephone: Woodley 3611.)

UNITED STEEL COMPANIES, LIMITED, is setting up a department to relate cybernetics to the iron and steel-making processes, under the direction of Mr. Stafford Beer, who has been production controller at Samuel Fox & Company, Limited, Stocksbridge. The department, which will start this year, will have a team of about 25 scientists.

THE TREASURY have made the Import Duties (Exemptions) (No. 16) Order, 1956, which continues for a further period of three months ending March 26, the exemption of titanium dioxide from duty chargeable under the Import Duties Act, 1932. The Order came into operation on December 27, 1956, and has been published as Statutory Instruments, 1956, No. 2005.

A £68,400 CONTRACT awarded to Barclay Curle & Company, Limited, Glasgow, to convert the Glasgow Corporation sludge boat, t.s.s. Delmarnock to operate on oil-burning boilers, has been lost because since placing the contract the highways committee of the Corporation have been informed by the Scottish Office that, in view of the need for economy in diesel oil, the conversion will have to be postponed.

Mr. M. V. JACKSON, technical representative of the Incandescent Group, has recently changed his address to "Hadfield House," Eccleshall Road South, Sheffield, 11 (telephone: Sheffield 65927). He deals with fuel-fired and electrically-heated furnace equipment, representing the Incandescent Heat Company, Limited, Metalectric Furnaces Limited, Controlled Heat and Air Limited, and Selas Gas and Engineering Company, Limited.

Brook Motors, Limited, announce the retirement of Mr. J. P. SWAIN, manager of their Leicester sales office. Mr. Swain, who has been associated with the company for 30 years, is succeeded by Mr. K. BROOM, A.M.I.E.E., who joined the firm in 1937 and underwent electrical engineering training at the Huddersfield works before being appointed technical adviser and sales engineer at Leicester in 1943, a position he has held up to the present time.

HUNSLET ENGINE COMPANY, LIMITED, locomotive manufacturers, Leeds, have secured a £150,000 contract from the Consett Iron Company, Co. Durham, for 11 steelworks locomotives. Ten years ago the Hunslet company received its first order—a six-wheeled diesel—from the Consett company, and when the new order is completed the company will have 23 locomotives in

News in Brief

service—one of the largest diesel fleets at any steelworks in the country.

Mr. ALEX MCKENZIE, technical advisory officer of the Birmingham Productivity Association, reports that "Many Birmingham and Midland workshops are more primitive than most people would believe. If work-study was effectively applied both the home and export market would benefit considerably." He said that competition was becoming keener and higher production might soon become the telling factor in whether or not some companies could meet that competition.

A BIG EXTENSION to Paisley Technical College is to be built within the next few years on a site to the north of the existing buildings. A competition among architects throughout Britain is at present being held, and prizes totalling £3,000 are to be awarded. The scheme has the approval in principle of the Scottish Education Department. A grant of 60 per cent. of the cost is expected, and an appeal is to be made soon to industry and benefactors for help in meeting the charge that will fall on the College.

BRITISH POLAR ENGINES, GLASGOW, are taking out a licence for the manufacture of the De Schelde reversible propeller, and have taken over the Controllable Pitch Propeller Company, which will be a subsidiary of British Polar Engines; the manufacture of the gear will be carried out at the Glasgow works. The firm have also embarked on the manufacture of the "T" size engine, giving 400 bhp per cc. at 250 r.p.m., and orders have been received for five of these engines, ranging from four to seven cylinders.

A SPECIAL COURSE at the Harwell reactor school, arranged by the UK Atomic Energy Authority, is designed to give those in industry a further opportunity to acquire basic knowledge of nuclear energy. The six-week course for about 60 will begin next June. It will cover the basic principles of the physics and engineering of reactors and will include lectures on such subjects as reactor metallurgy, shielding, and health physics. Emphasis will be placed on special topics such as the instrumentation of reactors and the use of radio-isotopes in industry.

Mr. F. A. HURST, chairman and managing director of Samuel Osborn & Company, Limited, Sheffield, recently presented awards totalling nearly £1,000 to 150 apprentices and staff for progress in studies. This was the highest sum ever distributed by the firm and compares with £750 distributed last year. The company also paid out over £20,000 in Christmas bonuses. This steel group employs about 3,000 and every employee over 21 years with at least six months' service received £5, a higher amount than last year, revealing a successful year. Increased money gifts were also given to the firm's 150 pensioners.

THE CORROSION GROUP of the Society of Chemical Industry are holding a conversazione on Thursday, January 24, in the Battersea Polytechnic, Battersea Park Road, London, S.W.11, commencing 6.30 p.m. Exhibits illustrating methods and results of corrosion research are being arranged, and films of technical interest, to be shown in the evening, include "Calder Hall" and "Zinc Controls Corrosion." Tickets are 5s. each, obtainable from the assistant secretary of the Society of Chemical Industry, 14, Belgrave Square, London, S.W.1, and applications should be made not later than January 10.

MR. W. LINDSAY BURNS, chairman of Henry Balfour & Company, Limited, who has just returned from a six-week business trip to North America, has brought with him contracts from companies in Canada and elsewhere for the manufacture of plant, machinery, and equipment for oil wells and natural gas production. The contracts, which are substantial, will entail making considerable extensions at the works in Leven to accommodate the highly specialized work involved. Mr. Burns said it is under consideration at the moment to bring the entire research laboratories from London to Fife. It is claimed that the new laboratories when built will be the most up to date in Britain.

AT A MEETING in Birmingham of the Midland Regional Board for Industry last month, it was stated that the cut in car production, due to the petrol shortage, was mainly responsible for a new upward swing in the number of workers on short time. The number working less than a full week was 24,000, Mr. J. W. Eldridge, Regional Controller of the Ministry of Labour, said. This deterioration in the employment position followed a progressive improvement throughout November when the number on short time dropped to fewer than 17,000. Major C. R. Dibben, chairman of the Board, said that the trend of trade in the Midlands was being well maintained despite all the difficulties.

TO COMMEMORATE their 25 years' service with Northern Aluminium Company, 32 employees at Birmingham, Banbury and Rogerstone were recently presented with watches by the managing director, Mr. Fraser W. Bruce. The presentations were made at special functions held in Knowle, Banbury and London, at which the guests included the directors, works managers, heads of departments and previous recipients of long-service awards. Though aluminium pocket watches, specially made for the company by a famous Swiss firm, were presented in 31 cases, an exception was made of Miss D. E. Batts, secretary to Mr. E. L. Ashley, Banbury works manager. She received a gold wristlet watch.

IN SPITE OF INCREASES in the cost of steel and other materials, there is urgent need for price restraint, Mr. J. E. Belliss (of Bellis & Morcom, Limited), president of the Birmingham Chamber of Commerce, warned local industrialists when he reviewed the country's economic situation at a recent meeting of the Chamber's Council. Britain was trying to do too much in attempting to carry the responsibilities of a great world power and at the same time trying to be the banker for the sterling area without having adequate gold and dollar reserves, he said. Calling for a complete reappraisal of British economic policy, he said more resources should be devoted to stimulating economic growth in the form of productive investment.

AT the annual dinner and dance of the Birmingham and District Industrial Safety Group, on December 19, Lord Pakenham said it was important that workers should feel confident that the management was really concerned about their safety. He is reported as saying: "The management of industry is disposed in the ordinary course of things to have regard to activities and unusual happenings which impede production," he said. "Every day there are 60,000 workers away from their jobs through industrial accidents and nearly 20,000,000 man days are being lost by industry yearly. Manpower losses through strikes are a small percentage in comparison." Lord Pakenham urged firms to train supervisory staffs in accident prevention and commended the activities of the Industrial Safety Group as an agency to use in such a programme. He said the safety of new plant or processes should be considered when they were being planned and not after there had been accidents from their use.

With only 4ft. 3in. width and 7ft. 6in. turning radius, working in confined spaces presents no difficulties.

The LH-1 is ideal for handling coke, limestone and miscellaneous rubbish—and the 5ft. 8in. tipping height brings lorry loading within the range of this versatile machine.

More and more foundries are finding that the Muir-Hill LH-1 Hydraulic Loader is the fast, economical answer to all bulk handling problems. With its 1,200 lbs. load rating, 10·5 cu. ft. bucket and 5ft. 8in. tipping height, this small and highly mobile lifting and carrying machine mechanises the handling of sand, small hot castings, scrap, coke, raw materials, etc., bringing power loading to bear in closely confined or restricted areas. Powered by a compact diesel engine and with sensitive hydraulic control of bucket and beam, the LH-1 means the end of wasteful, laborious bulk handling methods in foundries.

The

Muir-Hill LH-1

HYDRAULIC LOADER

★ *Dozing methods of cleaning up foundry sand emptied from moulding boxes tend to pack the sand, trapping undesirable steam and moisture. However, the lifting and discharging action of the LH-1 has the opposite effect, aerating the sand as it heaps it in readiness for the next filling of the boxes.*

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Raw Material Markets

Iron and Steel

As most industries closed for the same Christmas holiday period, there is little change in the position so far as order-books are concerned. The beginning of the year has found many establishments short of work and on short time, with the working week reduced to four days in some cases and three in others. So far as can be seen, little change can be expected for some time. This applies particularly to the foundries catering for the motor vehicle trade and to those supplying castings to the light engineering trades and to textile machinery makers. Their productive capacity is nowhere near fully occupied.

The supply of raw materials is fairly satisfactory and most units are able to acquire the pig-iron and scrap needed, apart from some tightening in the supply of high-phosphorus pig-iron, which is accounted for by the reduced output of this grade and the liquidation of stocks at some of the furnaces. The foundries were not surprised by the recent change in prices of pig-iron. What was a surprise was the extent of the increases, as it was not generally expected that they would be so steep. It is almost certain that the greater portion, if not the whole of the increase, will have to be passed on to the ultimate consumer. This may affect adversely the amount of business which can be secured, particularly for the export market. Competition for both home and export business is very keen.

Most of the re-rollers have good order-books and bright prospects for the opening of another year. Demand from home consumers continues at a good level and much export business is available when they are able to undertake it. The increase in the price of billets to the re-rollers of £1 10s. per ton will be compensated to some extent by the advance in price which they will obtain for their finished products, and so far as export business is concerned prices are still competitive with the Continental figures. It is not expected that the increase in price of the finished products will affect production seriously, at least for some months ahead, as order-books are full, and there are many unfulfilled demands for certain classes of re-rolled products, particularly rounds for reinforcing.

Non-ferrous Metals

Non-ferrous metal markets after the holiday break are featureless on both sides of the Atlantic. In copper, the New Year began with the general belief that the post-war period of shortage is over. Demand is steady, but not strong, while, despite cut-backs in production by major US producers, supplies continue to build up. Moreover, several new mines have come into production and the latest recruit to the ranks of producers, Bancroft, the new Rhodesian copperbelt producer, which was officially opened on Tuesday, is scheduled to produce 42,800 tons of copper this year and to double this output by early in 1960.

Tin is also quiet and the supply position easier largely because of the closing of the Texas smelter. Nevertheless, the price remains well above the point where the buying agent for the International Tin Council can operate. The news that the Suez Canal would not be open for ships of up to 10,000 tons for another three months and that a further three months would be required to restore the canal to its former efficiency is a bullish influence. Meanwhile stocks are low, although shipments are reaching their destinations as planned.

Lead, in common with other metals, is a quiet market, but the price is reasonably firm. Stocks are not high on either side of the ocean. Petrol rationing is not a helpful factor as, generally speaking, consumption for batteries depends on the number of cars on the road. In America the price is steady at 16 cents a pound.

Zinc is quietly steady and shows strong resistance to going to lower price levels. US barter transactions have depleted European stocks and demand is good. In the US, stocks are high and although the offtake of "Prime Western" at 13¼ cents a pound East St. Louis is satisfactory, demand for special high-grade metal continues to lag. Any revival in automobile production would soon reflect itself in a higher price for zinc.

Sir John Cass College

The Sir John Cass College, Jewry Street, Aldgate, London, E.C.3 announces amongst the technical courses commencing in the New Year, one on "Patents and Industrial Design Protection." This is to be given by Mr. Anthony Walton, M.A., barrister-at-law. The course starts on January 17. A second course is on "Microchemical Analysis" by Mr. A. G. Lidstone, M.A., B.SC., and Mr. David W. Wilson, M.SC., F.R.I.C., and starts on January 10. A third course is on "Emission Spectroscopy" by Dr. L. O. Freeman, M.SC., and Mr. D. B. Powell, B.SC., starting on January 18. These lecturers are also giving a further course, starting on May 3, on "Absorption Spectroscopy." The cost of each of these courses is £1 for those residing in the Administrative County of London. Further details are available on writing to the secretary of the College at the above address.

Deferment of Scientists and Engineers

Last month the Government decided to increase the number of scientists and engineers who may be granted indefinite deferment of National Service. Those affected are university graduates who complete courses of study or training in 1957 and who have first-class honours degrees in one of the main branches of science or engineering. They will be granted indefinite deferment of National Service only if they take up employment in this country which requires a science or engineering qualification of degree standard.

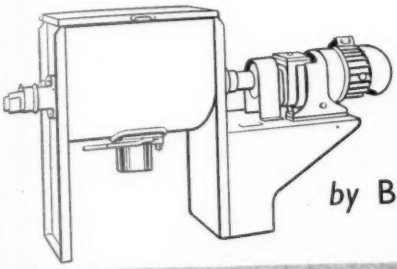
The decision was taken following representations from the Federation of British Industries about widening the opportunities of deferment for science and engineering graduates, so that more could take up employment in industry and thus alleviate, to some extent, the immediate shortages. The position will be reviewed at the end of next year.

CDA Returns to London

The Copper Development Association, whose headquarters have been at Kendals Hall, Radlett, Herts, since the end of the war, has returned to London, to spacious new premises at 55, South Audley Street, London, W.1, telephone GROsvenor 8811.

Atmospheric Pollution

A course of five lectures on "Atmospheric Pollution —its Causes, Effects, and Prevention," to be held on Tuesday evenings at 7.30 p.m., commences on January 22, at the Borough Polytechnic, Borough Road, London, S.E.1.



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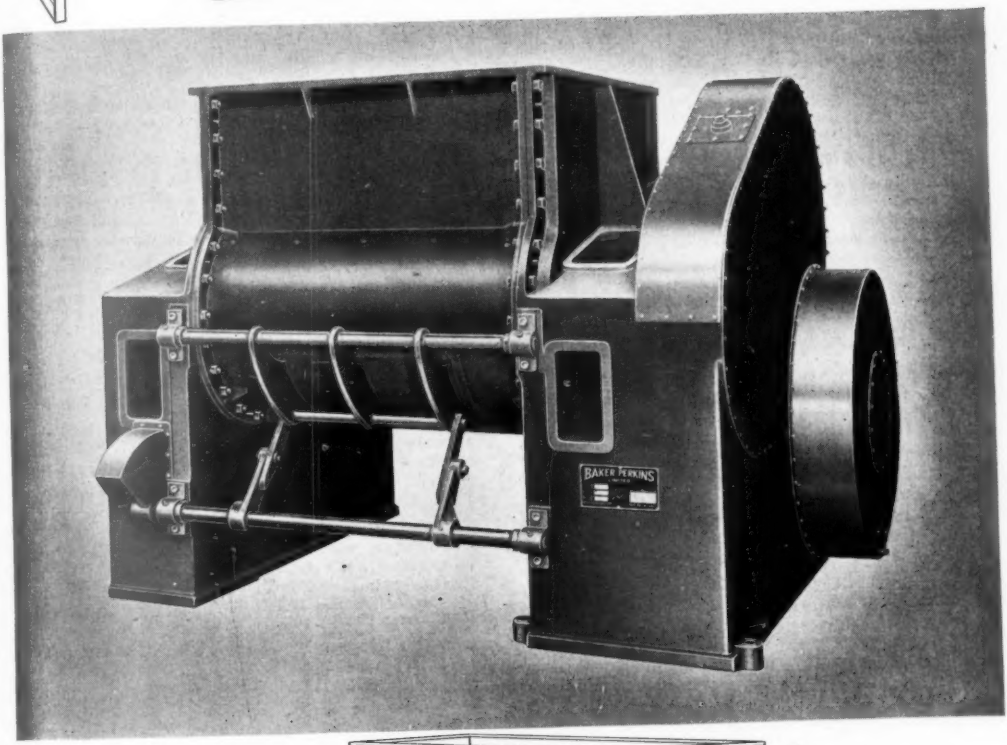

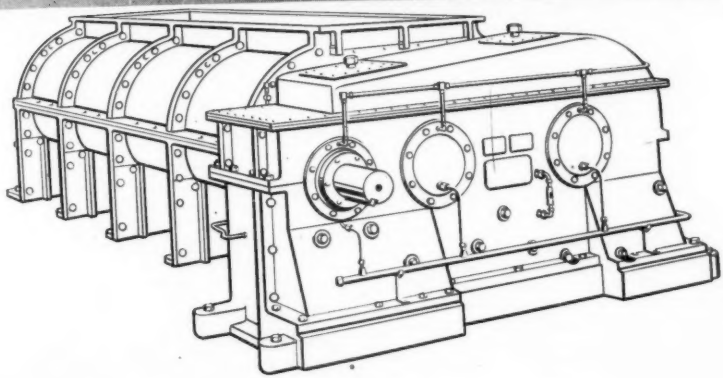

✳ ENQUIRIES should be addressed to The Foundry Sales Dept.

Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

January 2, 1957

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £20 1s. 0d.; Birmingham, £19 13s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £21 18s. 0d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £22 2s. 3d.

Scotch Iron.—No. 3 foundry, £23 4s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £24 6s. 6d.; South Zone, £29 9s. 0d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £25 14s. 0d.; South Zone, £25 16s. 6d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent. :—N.-E. of England (local iron), £22 17s. 6d.; Scotland (Scotch iron), Zone S. 1, £23 4s. 0d.; Sheffield, £24 4s. 6d.; Birmingham, £24 12s. 0d.; Wales (Welsh iron), £22 17s. 6d.

Basic Pig-iron.—£19 3s. 0d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots and over).—45 per cent. Si, £50 0s. 0d. to £51 15s. 0d., scale 17s. 0d. to 17s. 6d. per unit; 75 per cent. Si, £70 0s. 0d. to £75 7s. 6d., scale 17s. 0d. to 17s. 6d. per unit.

Ferro-vanadium.—50/60 per cent., 28s. 6d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 12s. 3d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £250 0s. 0d.; 38/40 per cent., £299 0s. 0d.

Ferro-tungsten.—80/85 per cent., 15s. 7d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 18s. 7d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent. C, £96 0s.0d. to £96 10s. 0d., basis 60 per cent. Cr, scale 33s. 0d. to 31s. 0d. per unit; over 6 per cent. C, £94 0s. 0d. to £95 10s. 0d., basis 60 per cent. Cr, scale 31s. 0d. per unit; 2 per cent. C,* 2s. 1½d. per lb. Cr; 1 per cent. C,* 2s. 2d. per lb. Cr; 0.15 per cent. C,* 2s. 2½d. per lb. Cr; 0.10 per cent. C,* 2s. 2¾d. per lb. Cr; 0.06 per cent. C,* 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 7s. 0d. to 7s. 6d. per lb.

Metallic Manganese.—90/92 per cent., carbon-free, £290 0s. 0d.; 96/98 per cent., £310 0s. 0d.

Ferro-columbium.—65/75 per cent., Nb + Ta, 22s. 6d. to 23s. 6d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £75 0s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £30 9s. 0d.; tested, 0.08 to 0.25 per cent. C, £31 9s. 0d.; hard (0.41 to 0.60 per cent. C), £32 10s. 6d.; silico-manganese, £41 0s. 0d.; free-cutting, £34 13s. 0d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £38 4s. 6d., silico-manganese, £41 7s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £36 3s. 6d.; basic, hard, over 0.41 up to 0.60 per cent., C, £37 6s. 0d.; acid, up to 0.25 per cent. C, £40 7s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £39 2s. 0d.; boiler plates (N.-E. Coast), £41 12s. 0d.; floor plates (N.-E. Coast), £40 11s. 0d.; sectional material, N.-E. Coast, £37 11s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested (4-ton lots), £37 18s. 0d.; flats, 5 in. wide and under (4-ton lots), £37 18s. 0d.; hoop and strip, £37 17s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £41 6s. 0d.; black sheets (hand mill), 17/20 g., £52 4s. 6d.; galvanized corrugated sheets, 24 g., £65 9s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £64 13s. 9d.; nickel-chrome, £88 15s. 3d.; nickel-chrome-molybdenum, £100 13s. 9d.

NON-FERROUS METALS

Copper.—Cash, £266 10s. 0d. to £267 0s. 0d.; three months, £265 10s. 0d. to £266 0s. 0d.; settlement, £267 0s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 2s. 7½d. per lb.; rods, 306s. 3d. per cwt. basis; 20 s.w.g., 339s. 6d. per cwt.

Tin.—Cash, £776 0s. 0d. to £777 10s. 0d.; three months, £765 0s. 0d. to £767 0s. 0d.; settlement, £777 10s. 0d.

Lead (Refined Pig).—First half January, £116 10s. 0d. to £117 0s. 0d.; first half April, £114 15s. 0d. to £115 0s. 0d.

Zinc.—First half January, £101 5s. 0d. to £101 10s. 0d.; first half April, £96 10s. 0d. to £97 0s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £133 5s. 0d.; rolled zinc (boiler plates), all English destinations, £131 0s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £110.

Brass Tubes, etc.—Solid-drawn tubes, 2s. 2d. per lb.; rods, drawn, 3s. 1¾d.; sheets to 10 w.g., 232s. 0d. per cwt.; wire, 2s. 10¾d.; rolled metal, 232s. 0d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £203; B6 (85/15), —; BS249, —.

Brass (High Tensile).—BS1400, HTB1 (30 tons), £255; HTB2 (38 tons), —; HTB3 (48 tons), —.

Gunmetal.—BS1400, LG2 (85/5/5/5), £278; LG3 (86/7/5/2), £287; G1 (88/10/2/½), £333; (88/10/2/1), £330.

Phosphor Bronze.—BS1400, PB1 (AID released), — per ton.

Phosphor Bronze Strip, etc.—Strip, 328s. 6d. per cwt.; sheets to 10 w.g., 328s. 6d. per cwt.; wire, 4s. 3¾d. per lb.; rods, 3s. 8d.; tubes, 3s. 6¼d.; chill cast bars: solids 3s. 8d., cored 3s. 9d. (CHARLES CLIFFORD, LIMITED).

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 4s. 0¼d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 5¼d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 4¼d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 5½d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £84 0s. 0d. Nickel, £600 0s. 0d. Aluminium ingots, £198 10s. 0d.; aluminium bronze (BS1400), AB1, £281; AB2, —. Solder, brazing, BS1945, type 8 (50/50), 3s. 1d. per lb., type 9 (54/46), 3s. 4½d. per lb.

* Average 68-70 per cent.

Forthcoming Events

JANUARY 7

Institute of British Foundrymen

Sheffield and district branch:—"Foundry Maintenance," by J. G. Jenkins, 7 p.m., at the Sheffield College of Commerce and Technology, Department of Engineering, Pond Street. (Joint meeting with the South Yorkshire branch of the Incorporated Plant Engineers.)

Lancashire branch:—"Co-operation and Co-ordination between Patternshop and Foundry," by E. H. Beech and N. Bradshaw, 7 p.m., at the Midland Hotel, Manchester.

JANUARY 8

Incorporated Plant Engineers

London branch:—"Acoustics and Vibration," by W. A. Hines, general manager, John Dale, Limited, 7 p.m., at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.

Manchester branch:—"Floor Loadings," by S. C. Swann, 7.15 p.m., at the Engineers' Club, Albert Square.

Institute of Metals

Oxford local section:—"Gases in Metals," by C. E. Ransley, M.Sc., Ph.D., F.I.M., 7 p.m., at the Cadena Café, Cornmarket Street.

Institution of Works Managers

Sheffield branch:—"Factory Act," by Mr. Hobson, 7.30 p.m., at the Grand Hotel.

JANUARY 9

Institute of British Foundrymen

Scottish branch:—"Malleable Castings for the Engineering Industry," by H. J. M. Conacher, 7.30 p.m., at the University College, Dundee. (Joint meeting with the Dundee Institute of Engineers:)

Burnley section:—"Hot-blast Cupolas," by J. Henderson, 7.30 p.m., at the Accrington College of Further Education, Sandy Lane.

Incorporated Plant Engineers

Leicester branch:—"Incentive Schemes for Maintenance Work," by D. J. Winfield, B.S.(Mech.Sc.), 7 p.m., at the Bell Hotel.

Western branch:—"Factory Electrical Distribution Schemes," by R. H. Cobbold, B.A., 7.15 p.m., at the Grand Hotel, Bristol.

JANUARY 10

Institution of Production Engineers

Leicester section:—"Material Handling for the Small Firm—Truck Methods," by R. A. Bishop, and "The Ohrneil System," by Mr. Brown, 7 p.m., at the Cromwell Room, Grand Hotel.

Incorporated Plant Engineers

Glasgow branch:—"Current Lubricants and their Significance to Plant Engineers," by S. F. Chisholm, 7.15 p.m., at the Scottish Building Centre, Sauchiehall Street.

North East branch:—"Space Heating," by F. W. Watson, 7 p.m., at Roadway House, Oxford Street, Newcastle-upon-Tyne.

Institution of Works Managers

Wembley sub-branch:—"Work Study," by F. E. Murray, 12.45 p.m., at the GEC Sports Pavilion, Preston Road, North Wembley.

Institute of British Foundrymen

Beds/Herts section:—"Reduction of Dust in the Production of Loose Pattern Moulds by Core Assembly," by E. H. Beech, 7.30 p.m., at W. H. Allen Sons & Company, Limited.

Stoke section:—"American Ferrous and Non-ferrous Foundry Practice," by T. Johnson, 7.30 p.m., at the Stipendiary Court Room, Hanley.

JANUARY 11

Institute of Vitreous Enamellers

Midland section:—Annual dinner at the Station Hotel, Dudley, Worcs., 7.15 for 7.30 p.m.

Institute of British Foundrymen

Tees-side branch:—"Practical Aspects of the Uses of CO_2 in the Foundry," by G. B. Taylor, 7.30 p.m., at the Teesdale Hall, Head, Wrightson & Company, Limited, Thornaby-on-Tees.

JANUARY 12

Institute of British Foundrymen

Newcastle branch:—Discussion on foundry problems, 6 p.m., at the Neville Hall, Westgate Road.

Scottish branch:—"Improvized Methods of Shell Production," by T. H. Weaver, 3 p.m., at the Royal Technical College, George Street, Glasgow.

Northampton section:—Foundry Brains Trust, 6 p.m., at the Plough Hotel. (Meeting originally arranged for January 19.)

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Pig-iron and Steel Production

Statistical Summary of October Returns

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation. Table I summarizes activities during the past six months. Table II gives production of steel ingots and castings in October, and Table III, weekly average production of finished steel. Table IV gives the production of pig-iron and ferro-alloys in October, 1956, and furnaces in blast. (All figures weekly averages in thousands of tons.)

TABLE I.—*Iron and Steel Price Index and General Summary of Pig-iron and Steel Production.*

Period.	B.o.T. Price Index, 1938 = 100.			Iron-ore output.	Imptd. ore used.	Coke to blast-furnaces.	Pig-iron, ferro-alloys prod.	Scrap used in steel prod.	Steel (incl. alloy).			
	I. & S.	Coal.	Basic[1] materials (excl.fuel).						Imports.[2]	Prod. ingots, castings.	Delivrs. finished steel.	Stocks.[3]
1953	260	350	506	304	207	237	215	188	17	339	262	962
1954	263	364	498	299	234	238	229	198	7	356	277	931
1955	276	399	529	311	244	246	240	213	29	381	305	1,183
1956—May[4]	297	433	541	306	274	255	247	213	29	396	321	1,306
June ..	300	461	539	302	256	252	240	209	27	390	324	1,315
July ..	300	463	535	288	252	258	240	179	24	326	275	1,334
Aug.[4]	300	463	541	279	258	259	236	179	18	341	227	1,499
Sept. ..	300	464	545	301	269	267	253	231	18	417	330	1,453
Oct.[4] ..	300	464	540	317	279	266	261	229	21	419	—	1,382

TABLE II.—*Weekly Average Production of Steel Ingots and Castings in October*, 1956.

District.	Open-hearth.		Bessemer.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derby, Leics., Notts., Northants and Essex ..	—	4.1	14.8 (basic)	2.6	0.1	20.2	1.4	21.6
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire	1.5	34.2	—	2.6	0.4	37.2	1.5	38.7
Yorkshire (excl. N.E. Coast and Sheffield) ..								
Lincolnshire	—	40.7	—	—	0.1	40.6	0.2	40.8
North-East Coast	0.9	80.5	—	1.6	0.5	81.3	2.2	83.5
Scotland	3.1	46.1	—	2.9	0.5	50.1	2.5	52.6
Staffs., Shrops., Worcs. and Warwick	—	20.0	—	1.2	0.7	20.1	1.8	21.9
S. Wales and Monmouthshire	5.7	81.2	7.4 (basic)	1.2	0.2	95.0	0.7	95.7
Sheffield (incl. small quantity in Manchester) ..	8.6	35.1	—	12.4	0.5	54.5	2.1	56.6
North-West Coast	0.1	1.9	5.0 (acid)	0.6	0.1	7.5	0.2	7.7
TOTAL	19.9	343.8	27.2	25.1	3.1	406.5	12.6	419.1[5]
September, 1956	21·1	342.6	25.0	25.2	3.1	404.4	12.6	417.0
October, 1955	20.6	326.1	26.7	23.0	3.1	387.4	12.1	399.5

TABLE III.—*Production of New Non-alloy and Alloy Finished Steel.*

Product	1954.	1955.	1955.	1956.	
			Sept.	August[4]	Sept.
Non-alloy steel:					
Ingots, blooms, billets and slabs[6]	5.1	4.9	5.7	3.3	5.3
Heavy rails ..	9.6	9.4	10.3	6.7	11.1
Sleepers, etc. ..	1.9	2.0	1.8	0.9	1.2
Plates ¼ in. thick and over ..	47.0	46.1	50.2	38.9	55.3
Other heavy prod. ..	45.8	47.8	50.8	35.1	52.9
Ferro-concrete bars and rods ..	5.9	7.0	7.3	5.9	8.2
Wire rods (incl. coiled rods) ..	19.7	22.2	22.9	17.8	23.1
Light rolled prod. ..	41.2	46.4	48.8	35.6	54.9
Bright steel bars ..	6.3	7.8	8.5	5.3	7.9
Hot-rolled strip ..	21.7	24.1	26.2	14.8	26.4
Cold-rolled strip ..	7.0	8.1	9.0	4.5	7.6
Sheets (incl. coated)	38.8	42.7	42.5	29.9	42.7
Tin, terne and blackplate ..	16.8	17.0	18.2	11.8	18.6
Steel tubes, pipes	20.0	22.9	26.4	20.0	27.2
Tube, pipe fit'gs (excl. flanges) ..	0.4	0.4	0.5	0.3	0.5
Tyres, wheels, axles	4.7	4.8	4.9	3.2	4.4
Forgings (excl. drop forgings) ..	2.6	2.5	2.7	2.0	3.4
Steel castings ..	4.0	4.2	4.6	3.3	5.0
Tool and magnet steel	0.2	0.3	0.3	0.2	0.3
Total	298.7	320.6	341.6	239.5	356.0
Alloy steel	13.6	15.8	17.7	10.7	19.2
Total deliveries from U.K. prod.[6] ..	312.3	336.4	359.3	250.2	375.2
Add : Imported finished steel ..	5.0	18.8	27.4	11.2	13.6
	317.3	355.2	386.7	261.4	388.8
Deduct: Intra-industry conversion[7] ..	41.9	50.9	58.8	35.9	60.4
Total new material ..	275.4	304.3	327.9	225.5	328.4

TABLE IV.—*Production of Pig-iron and Ferro-alloys during October* 1956.

District.	Furnaces in blast.	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts., Northants and Essex	27	1.7	27.9	22.8	0.5	—	52.9
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire .. Yorkshire (excl. N.E. Coast and Sheffield) ..	7	—	19.2	—	—	1.7	20.9
Lincolnshire ..	9	—	35.2	—	—	—	35.2
North-East Coast	20	4.7	48.1	—	—	—	52.8
Scotland ..	9	0.7	16.3	1.8	—	—	18.8
Staffs., Shrops., Worcs. and Warwick ..	6	—	10.5	1.4	—	—	11.9
S. Wales and Monmouthshire	10	4.4	37.4	—	—	—	41.8
Sheffield	2	—	3.4	—	—	—	3.4
North-West Coast	8	21.2	—	0.1	—	1.7	23.0
Total ..	98	32.7	198.0	26.1	0.5	3.4	260.7[4]
September, 1956	99	30.7	190.9	26.6	1.1	3.2	252.5
October, 1955 ..	98	29.4	188.6	27.6	0.8	2.8	249.2

[1] Used in non-food manufacturing industry.
[2] Weekly average of calendar month.
[3] Stocks, mainly ingots and semi-finished, at the end of the years and months shown.
[4] Five weeks, all tables.
[5] Other than for conversion into any other form of finished steel listed.
[6] Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.
[7] Material for conversion into other products also listed in this table